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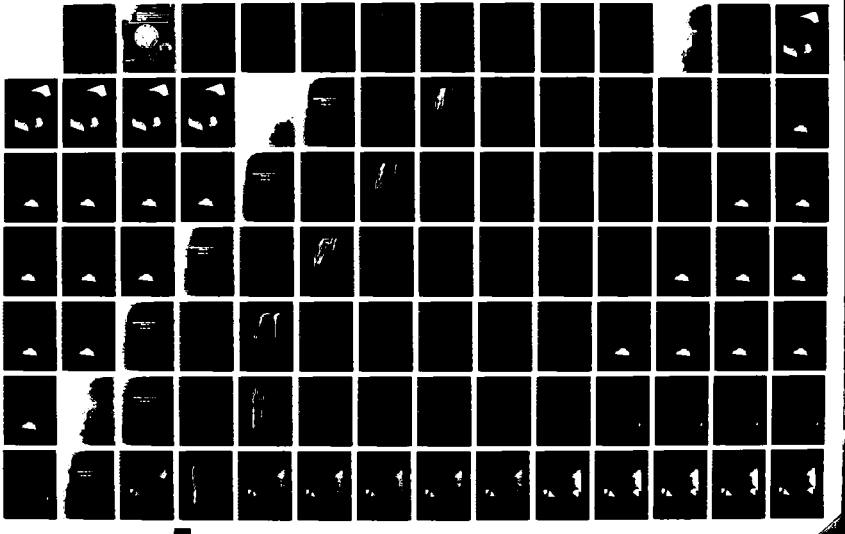

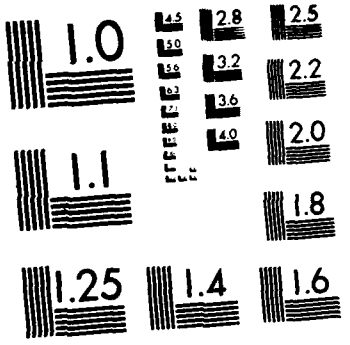

NORDA Technical Note 341

Preliminary Report: Environmental Conditions in the Norwegian-Iceland Seas, May 1987

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June 1987

PRELIMINARY REPORT: ENVIRONMENTAL CONDITIONS IN THE NORWEGIAN-ICELAND SEAS, MAY 1987

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ABSTRACT

(U) In support of the Tactical Oceanography Prediction Experiment an extensive series of thermal structure measurements have been made in the Iceland and Greenland Seas with emphasis on the Iceland-Faeroe frontal region. A preliminary analysis of these measurements is given.

INTRODUCTION

(U) This preliminary report describes field work carried out by NORDA personnel and NORDA sponsored personnel during the period 15-30 May 1987. This is the initial phase of a continuing series of field experiments in the Greenland, Iceland, and Norwegian seas in support of the National Maritime Strategy. The field work was divided into four segments: (1) aircraft observations using air deployed expendable bathythermographs (AXBTs) dropped from a Naval Research Laboratory (NRL) P-3; (2) near-real-time tactical scale thermal analyses and oceanographic predictions by NORDA at the Anti-Submarine Warfare Operations Center (ASWOC), Keflavik, Iceland; (3) near-real-time tactical scale ocean dynamic forcasts at the Naval Oceanography Command Facility (NOCF), Keflavik, Iceland, by the Harvard team (Alan Robinson, Donald Denbo, Scott Glenn, Michael Spall, and Leonard Walstad) using an open ocean model; and (4) ship observations aboard the West German ship PLANET. This report concentrates on the first two segments by briefly describing the field efforts and the analysis/forecast segment of the operation. Some initial findings concerning the environmental conditions in the Norwegian-Iceland Seas during May 1987 with figures detailing these conditions conclude the report. In-depth summaries of the results will follow in later publications.

TACTICAL OCEANOGRAPHY PREDICTION EXPERIMENT

(U) One of NORDA's major long range goals is the development, validation and delivery for operational use of oceanic and acoustic numerical forecast systems, and the assimilation of in-situ and remotely sensed data into these forecast systems. The Tactical Oceanography Prediciton Experiment, a key element of this goal, is designed to provide the exploratory development for the future integration of ocean measurements, dynamic and thermodynamic numerical ocean models,and range dependent numerical acoustic performance prediction models into an end-to-end prediction system running on the Standard Navy Desktop Computer.

(U) The Tactical Oceanography Prediction Experiment can be viewed as a set of four tasks:

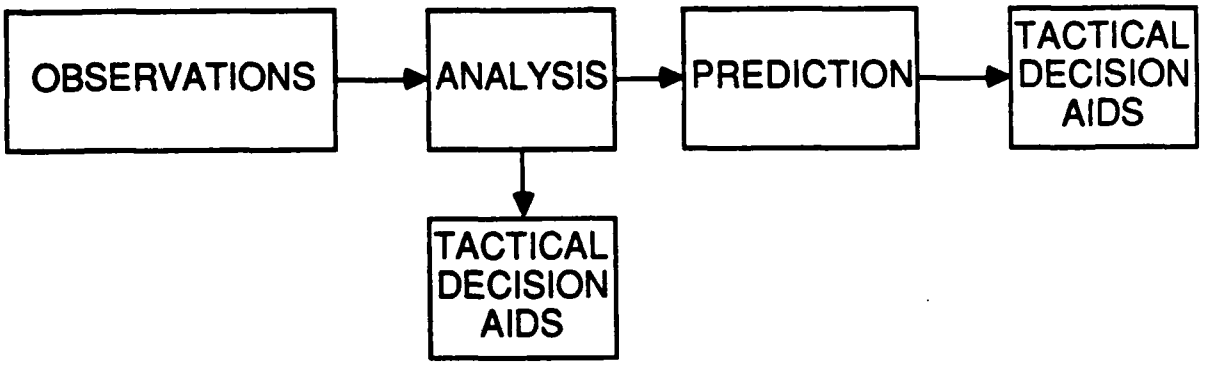

Figure 1. Tactical Oceanography Prediction Experiment.

(U) OBSERVATIONS. The observational component had five goals: (1) to provide near-real-time initialization and validation fields of the Iceland-Faeroe Front, via NORDA's desktop version of the Optimal Thermal Interpolation System (OTIS), for NORDA's desktop computer version of the Thermodynamic Ocean Prediction System (TOPS); (2) to provide near-real-time initialization and validation fields of the Iceland-Faeroe Front for the Harvard open boundary ocean dynamic prediction model; (3) to provide initialization fields for the NORDA ocean circulation model of the Greenland-Iceland-Norwegian Seas; (4) to provide near-real-time analyzed and predicted sound speed fields for range dependent acoustic predictions on tactical scales; (5) to contribute to an improved understanding of the regional hydrography, circulation, and frontal structure of the region. These goals were viewed as ambitious but achievable within the context of several experimental phases. All goals were met to a greater or lesser extent during this first experiment, although considerable improvement of technique still remains to be accomplished.

(U) ANALYSIS. The goal of the thermal analysis task was primarily to produce near-real time objective maps of the ocean thermal structure on a local microcomputer. These uniform fields were to be available for (1) displays to aid further data gathering efforts, (2) boundary and initial conditions for numerical models, and (3) environmental fields for input to the range-dependent acoustic models. The figures shown in this report are representative of the output generated by this task.

(U) PREDICTION. The goal of the prediction element was threefold: (1) using TOPS together with the winds forecasted by the Navy Operational Global Atmospheric Prediction System (NOGAPS) predict in near-real time the thermal structure of the Iceland-Faeroe front for upto 72 hours; (2) using the Harvard open ocean model (GAPCAST) predict in near-real time the currents in the frontal region for upto a week; (3) using a range dependent acoustic model predict the acoustic propagation across the front.

(U) TACTICAL DECSION AIDS. The goal of this element is the development of graphical representation of the information from the analysis and prediction elements for the tactical decision maker to aid in resource allocation.

DATA COLLECTION AND ANALYSIS

(U) Eight research flights were conducted by NORDA personnel on board a Naval Research Laboratory P-3 aircraft opearating out of Keflavik, Iceland between 15 and 30 May 1987. Four hundred twenty shallow (nominally 305 m) and fifty deep (nominally 750 m) AXBTs were successfully deployed and analyzed. The dates and regions of operations were:

Flight	Date	Region
1	15 May 1987	Iceland-Faeroe Front
2	18 May 1987	Iceland-Faeroe Front
3	20 May 1987	Jan Mayen Front
4	22 May 1987	Iceland-Faeroe Front
5	24 May 1987	Iceland Sea
6	26 May 1987	Iceland-Faeroe Front
7	28 May 1987	Southern Norwegian Sea
8	30 May 1987	Northern Norwegian Sea

These regions are shown schematically in Figure 2.

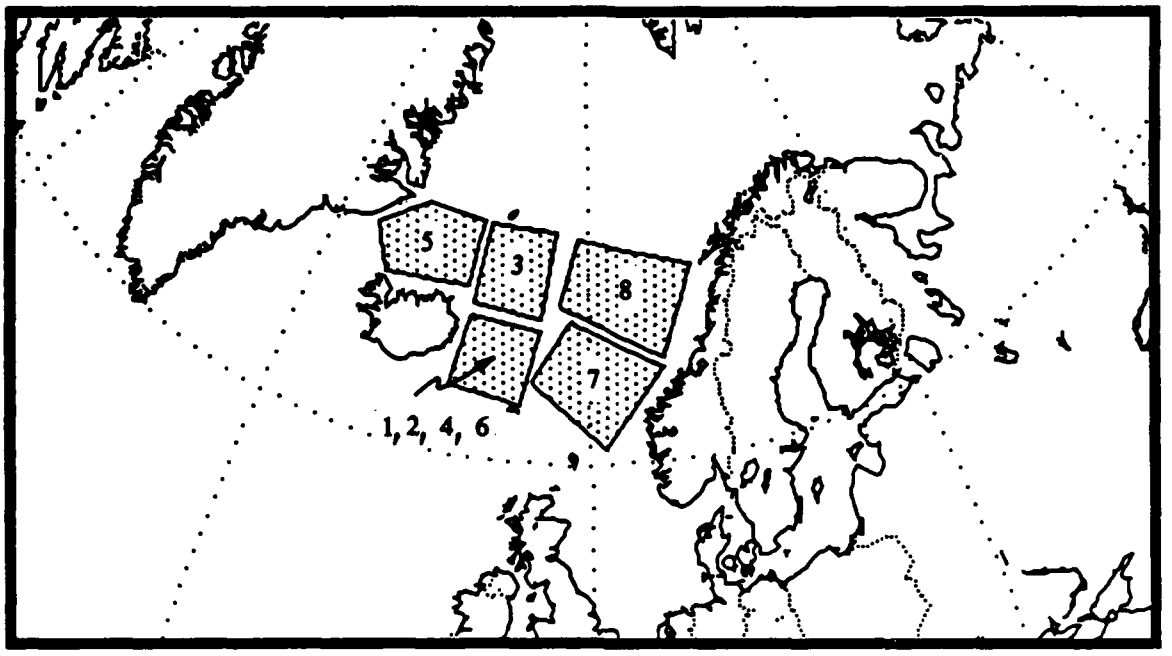

Figure 2. Aircraft measurement areas.

(U) The data were collected using two micro-computer based data acquisition systems, plotted in near real-time, and had major inflection points digitized by hand (flights 1-4) or with a digitizing tablet (flights 5-8) immediately after conclusion of each flight. (The initial data acquisition system had to be replaced by the second due to a computer failure.) Navigation information was merged with the profiles, and the data was checked against climatology to eliminate bad traces that were not apparent to the eye. The edited data was then both passed to the Harvard team for their use and analyzed by the NORDA TTAP (Tactical Thermal Analysis Package) thermal analysis system. All data was digitized and analyzed within 24 hours of conclusion of a flight.

(U) The NORDA Tactical Thermal Analysis Package (TTAP) is a FORTRAN coded software package that allows the user to manipulate the AXBT data in various ways. It includes provisions for plotting the data values at arbitrary depths on a map of the experimental area as well as plotting station designators and individual or overlayed temperature vs. depth plots. Most importantly, it provides a method for producing uniformly gridded fields from the somewhat randomly spaced experimental measurements. These meshed fields can be arranged on horizontal planes as temperature contours at a given depth, or on vertical planes as vertical temperature cross-sections. These programs were were designed to operate on a microcomputer capabilities that approximate that of an IBM-PC/AT

(U) The method used to obtain the temperature estimates at the grid nodes of the user-defined mesh is that of optimal estimation (statistical interpolation). This method bases its estimates on the spatial and temporal covariance functions of the field of interest (Gandin, 1963). For this analysis

a simple exponential representation of the covariance function was chosen. The scale of the exponential decay (e-folding distance) is chosen to fit the sampling scheme and the scales of interest in the temperature field. For the Iceland-Norwegian Sea experiment the horizontal scale was chosen to be 50 km. Temporal and vertical correlations were not considered for this experiment. The analyses shown in this report use a grid spacing of about 10 km. The initialization or "first guess" field used was the Global Digital Environmental Model (GDEM), which is defined on a 0.5 degree grid, interpolated to the grid of interest. Although they were originally performed on a Zenith Z-248 operating on site at the ASWOC in Keflavik, Iceland, the calculations were repeated at a higher resolution on a VAX 8800 for this report.

ENVIRONMENTAL CONDITIONS, MAY 1987

(U) The NORDA thermal analysis system (TTAP) was used to produce the following figures. They fall into four appendices: (A) analyses of the full 15-day dataset covering the Iceland and Norwegian Seas; (B) analyses of the four intensive surveys of the Iceland-Faeroe Frontal Zone; (C) analyses of the Jan Mayen Frontal Zone, Iceland Sea, and southern and northern Norwegian Sea surveys; and (D) temperature versus depth cross-sections along selected transects through the major frontal regions.

Appendix (A) Norwegian-Iceland Sea

(U) The first few figures show the near-synoptic composite picture given by combining all eight Norwegian-Iceland Seas operations. The flights covered the region with 20-60 nmi resolution between about 61°N - 70°N and were designed to provide an initialization field for the NORDA regional ocean circulation model of the area as well as to advance the understanding of the regional hydrography, circulation, and frontal structure.

(U) The major frontal features of the area are quite clear in the temperature contours at 0, 100, 200, 300, and 400 m: the Kolbeinsey Current Front north of Iceland, the Iceland-Faeroe Front between Iceland and the Faeroe Islands, the Jan Mayen Front north of 65° N and between 5-10° W, and the Norwegian Current Front between about 0-6° E. All the frontal positions lie close to their 1980-81 locations as described by Smart (1984). No sign of the East Greenland Front paralleling the eastern Greenland coast can be seen, although visual observations were made from the aircraft during the Iceland Sea survey (24 May) of an ice-free region all along the Greenland
coast and extending offshore 10-20 miles which conceivably could have been the East Greenland Current flowing very close to the coast.

Appendix (B) Iceland-Faeroe Frontal Zone Intensive Studies

(U) The four intensive (20-30 nmi spacing) surveys of the Iceland-Faeroe Frontal Zone were designed to provide initialization and validation data for mixed layer and local scale circulation modelling. From these surveys considerable information can be gained about the temporal and spatial structure of the front. Each series of figures in this section consists of: (a) successful AXBT drop locations and corresponding station numbers; (b) a composite temperature versus depth plot of all traces; (c) drop locations and corresponding temperature values at 0, 100, 200, 300, and 400 m; (d) horizontal contours of the temperature data in (c).

(U) The composite temperature versus depth plots are distinctly bimodal, with the colder near-surface profiles representing water of Arctic origin, while the warmer near-surface profiles are from water of Atlantic origin. The development of a mixed layer over the intervening 11 days, especially in the Atlantic water, is evident in the later surveys.

(U) The Iceland-Faeroe Front is well resolved at all depths and located in the southern portion of the range suggested by Smart (1984). The frontal slopes down to the south, although it is more clearly seen in the vertical transects in Appendix (D). A noteworthy feature is the northward bulge of the front between about 10-12° W which persisted throughout the surveys, although its shape and depth of penetration varied. A very distinct warming trend penetrating all the way to 400 m appeared by the fourth survey on 26 May.

Appendix (C) Jan Mayen Front, Iceland Sea, and Southern and Northern Norwegian Sea Studies

(U) The Jan Mayen frontal zone lies between the Iceland and Norwegian Seas. This is clearly seen in the bimodal structure of the composite temperature versus depth plot for the 20 May survey. One group of profiles with near-surface values between 0 and 2.5° C corresponds to Iceland Sea waters which have been formed in the region, while the other group (near-surface temperatures of about 3.5 to 6° C) represents Norwegian Sea waters of Atlantic water origin. The Jan Mayen Front itself is clearly seen in the subsequent plots as a distinct but rather diffuse front centered around 7° W. The cross-frontal temperature change was around 3° C, and the front was visible to at least 400 m. It extended primarily north-south, with a distinct westward bulge in its most intense region between 68 and 69° N.

(U) The Iceland Sea operations on 24 May were conducted over extensive areas of 40-70% ice cover except relatively close to Iceland and within a few tens of miles of the Greenland coast. Much of the ice was presumably fairly thin, since east of about 22° W the AXBT success rate was only somewhat degraded. West of 22° W the character of the ice changed into much larger agglomerations while the probe success rate plummeted to nearly 0, and the flight was terminated early.

(U) The composite temperature versus depth plot for this survey shows four different profile regimes. The first, with near-surface values of about -1.5 to -1° C, occurred in the northwestern portion of the area and represented Polar water originating in the Arctic and brought into the region by the East Greenland Current. The second group of profiles (near-surface temperatures in the -0.5 to 0.5° range) lay predominatly to the northeast and consisted of the locally formed Iceland Sea water. The third group, rather broadly distributed between 1 to 2.5° C, probably consisted of waters formed from the mixing of one or both of the first two types with the fourth. This fourth group, with near-surface temperatures of 3.5 to 6° C , was water of Atlantic origin, part of the current flowing around Iceland and passing eastward along the island's northern coast, which is known variously as the Kolbeinsey Current, the East Icelandic Current, or the Iceland Current.

(U) The frontal zone between the Kolbeinsey Current water and the Polar and Arctic waters to the north is very apparent in the subsequent plots in this section. As also noted by Smart (1984), the front slopes downward to the south, reflecting topographic influences. Its near-surface manifestation bows outward to the north, while at depth it more closely parallels the Icelandic coastline.

(U) Figures for the southern and northern Norwegian Sea surveys are grouped somewhat

differently from the other surveys. We first present the drop locations, composite temperature versus depth plots, and drop locations with corresponding temperatures at 0, 100, 200, 300, and 400 m for the individual surveys. Following these figures are the temperature contours at the four depth levels for both surveys combined.

(U) The composite temperature versus depth plots are unimodal. The near-surface temperatures range between 4.5-9.5° C, and represent Norwegian Atlantic Current water of North Atlantic origin and mixtures of this water with Norwegian Sea water. Considerable structure and temperature inversions characteristic of frontal regimes can be seen in some of the profiles, particularly in those from the southern Norwegian Sea survey.

(U) The Norwegian Current Front is apparent in the western half of the temperature contour plots at 0, 100, 200, 300, and 400 m. It is more easily seen at 100 m and below than at the surface, and north of 65-67° N bends westward and becomes considerable more poorly defined. A downward slope of the front to the east toward Norway reflects topographic effects.

Appendix (D) Temperature versus depth transects

(U) Three temperature versus depth transects were drawn through the major frontal zones in the Norwegian-Iceland Seas: (1) from 12° W, 63° N to 8° W, 66° N through the Iceland-Faeroe Front; (2) from 14° W, 69° N to 6° E, 66° N through the Jan Mayen and Norwegian Current Fronts; and (3) from 18° W, 66.5° N to 20° W, 70° N through the Kolbeinsey Current Front. A brief discussion of some of the major features of each transect follows.

(U) The first set of transects is for the four intensive Iceland-Faeroe Frontal Zone surveys. The front was very well resolved on all four surveys. On 15 May it was nearly vertical, but by 18 May the upper 50 m appeared to have been moved notheastward by 50 km or so and the surface definition spread out, presumably by advective effects. On 22 May the whole frontal signature was less intense at all depths, and a distinct frontal slope downward to the south of about 200 m in 100 km can be seen. Four days later, on 26 May, the southern 100 km of the area became noticeably warmer, with the warming trend becoming particularly noticeable and penetrating farther north in the upper 50 m or so. The intensity of the front also increased.

(U) A final comment concerns the location of the deep portion of the front, which might be expected to be more stable than the surface portion because of the influence of bathymetry on its location. This may be true for the front as a whole, but the deep position of the front along our selected transect seemed to vary significantly on time scales of only a few days during May 1987. On 15 May the front at 400 m was located between approximately kilometers 95 and 170 along the transect. A portion of the front remained in this general vicinity during subsequent surveys, but beginning on 22 May another part of the front seemed to form between kilometers 0 and 50 along the transect and became its more significant manifestation.

(U) While the Jan Mayen front and the gradient associated with the Norwegian Current are clearly visible in the transect across the northern Norwegian Sea, these fronts are not nearly as intense as that along the Iceland-Faeroe ridge. As a comparison both the Jan Mayen and Norwegian current temperature gradients are about 1 C in 60 km whereas the Iceland-Faeroe gradient is as high as 1° C in 10 km. The Jan Mayen front (about 300-400 km range in the figure) is quit vertical in this realization except perhaps near the surface. The Norwegian current (at about 700 km range in the figure) is also well defined but with not nearly such vertical isotherms. An intrusion of warm surface water (> 8° C) is a prominent feature which defines the surface

expression of the Norwegian current.

(U) The Kolbeinsey Current Front is clearly visible in the south-to-north transect which concludes the figures. The water to the north of this front is a nearly homogenous 0° C representing cold Iceland Sea water. Judged by some historical references the frontal position is rather far offshore--the warmer (3-4° C) water of the costal Iceland current occupying the nearest 150 km along the Icelandic coast. One interesting feature of the transect is the reverse slope of the surface isotherms near the 180 km range.

ACKNOWLEDGEMENTS

(U) The efforts and cooperative spirit of LCDR Jim Jarvis and the other officers and crew of the Naval Research Laboratory P-3A #150607 are gratefully acknowledged. Glen McCardle of the NORDA Ocean Technology Division ably operated the data acqusition systems on board the aircraft and successfully tackled the many problems that arose. Heartfelt thanks are due to Ron Miles and Robert Brown, also of the NORDA Ocean Technology Division, without whose long-distance problem solving skills the operations would not have succeeded. At the Naval Air Station, in Keflavik, Iceland we could not have operated without the help of individuals from the Naval Oceanography Command Facility and the Anti-Submarine Warfare Operations Center. Particular thanks should be given to CDR R. T. Pearson, LT K. A. Wos, LT M. B. Clifford, and CDR R. C. McIntosh.

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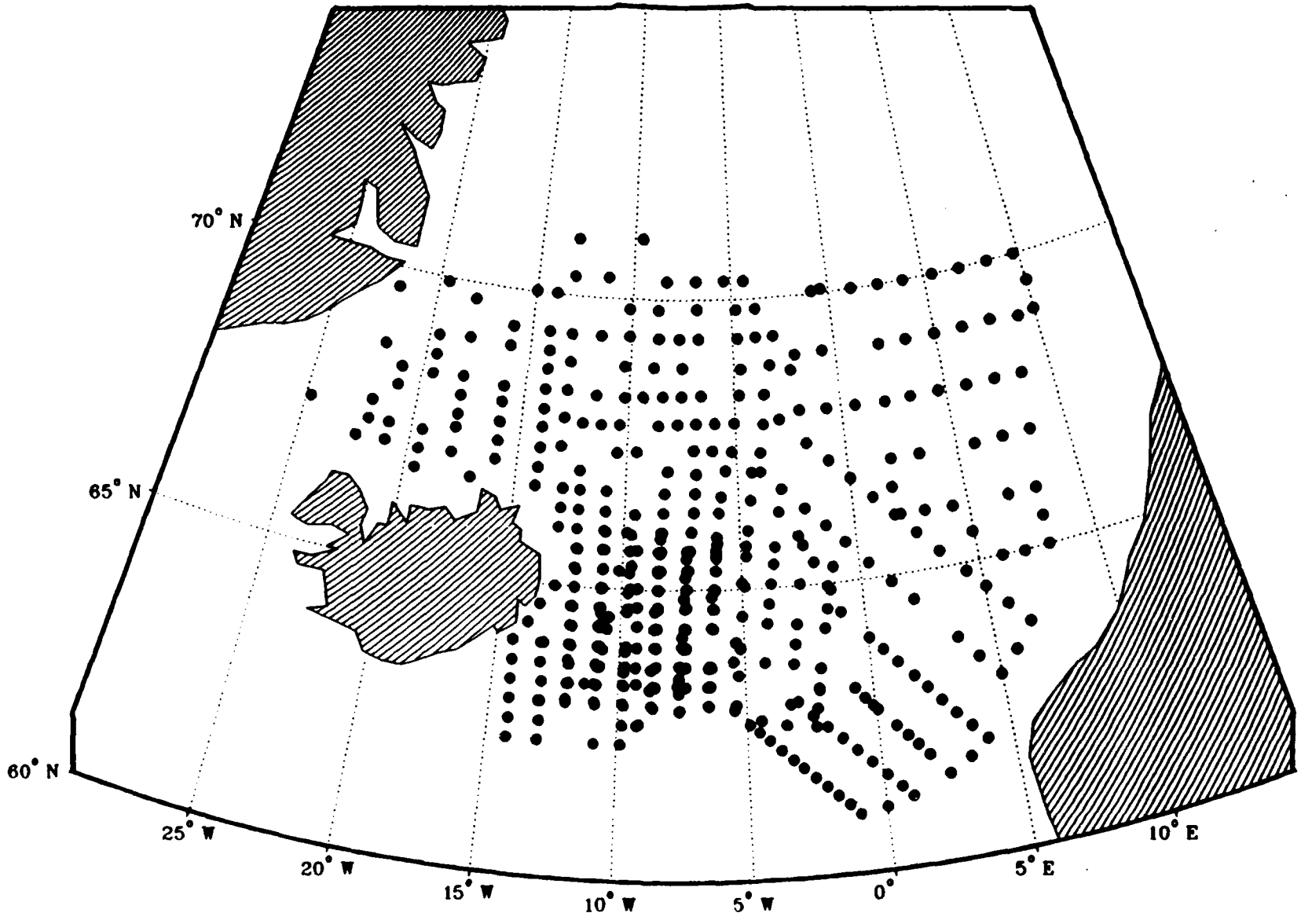
Gandin, L.S. 1963. Objective Analysis of Meteorological Fields. Leningrad, Gidromet. (Jerusalem, Israel Program for Scientific Translations, 1965. 242pp. available as NTIS TT65-50007)

GIN Sea Survey, May 1987
AXBT Stations



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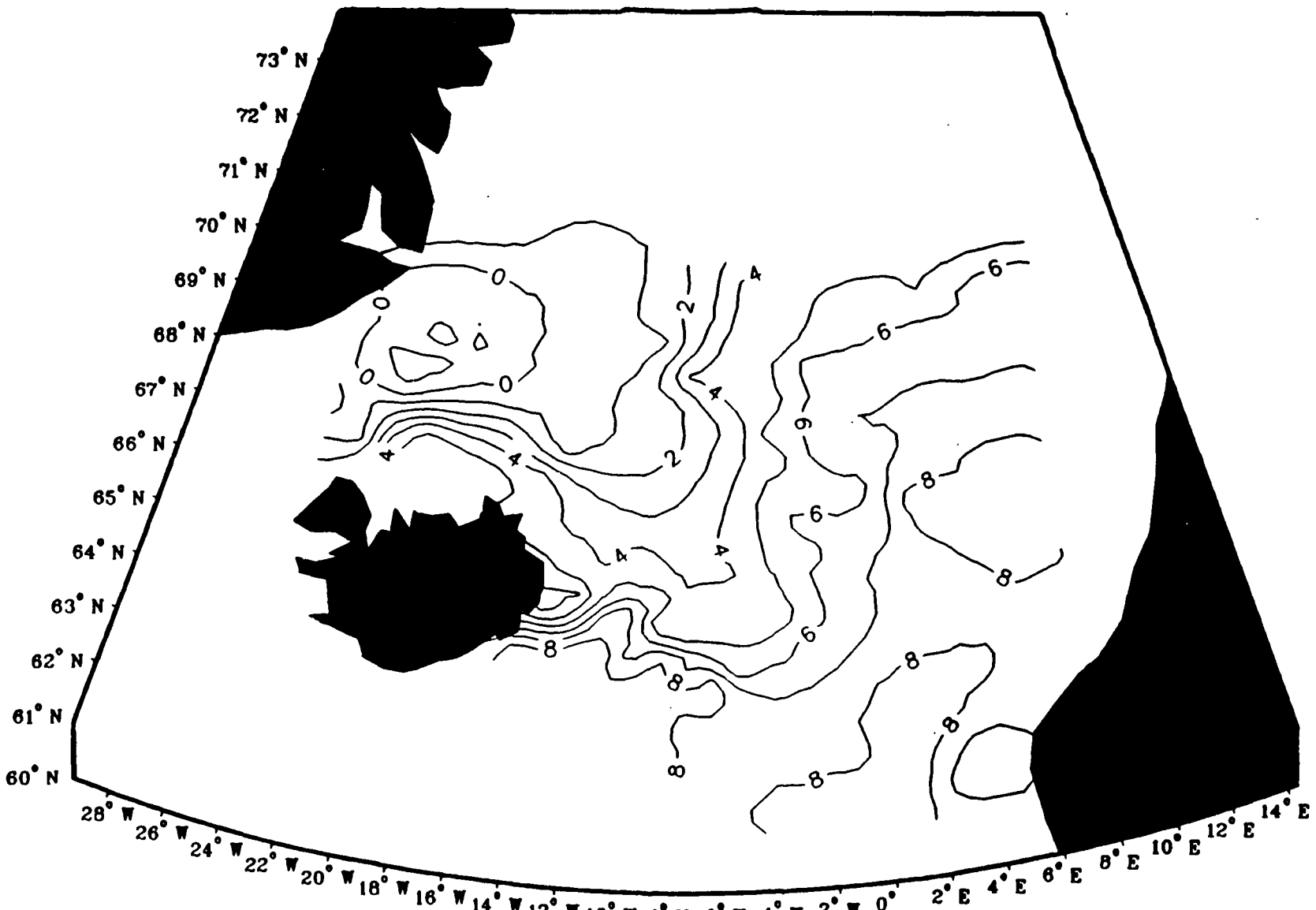

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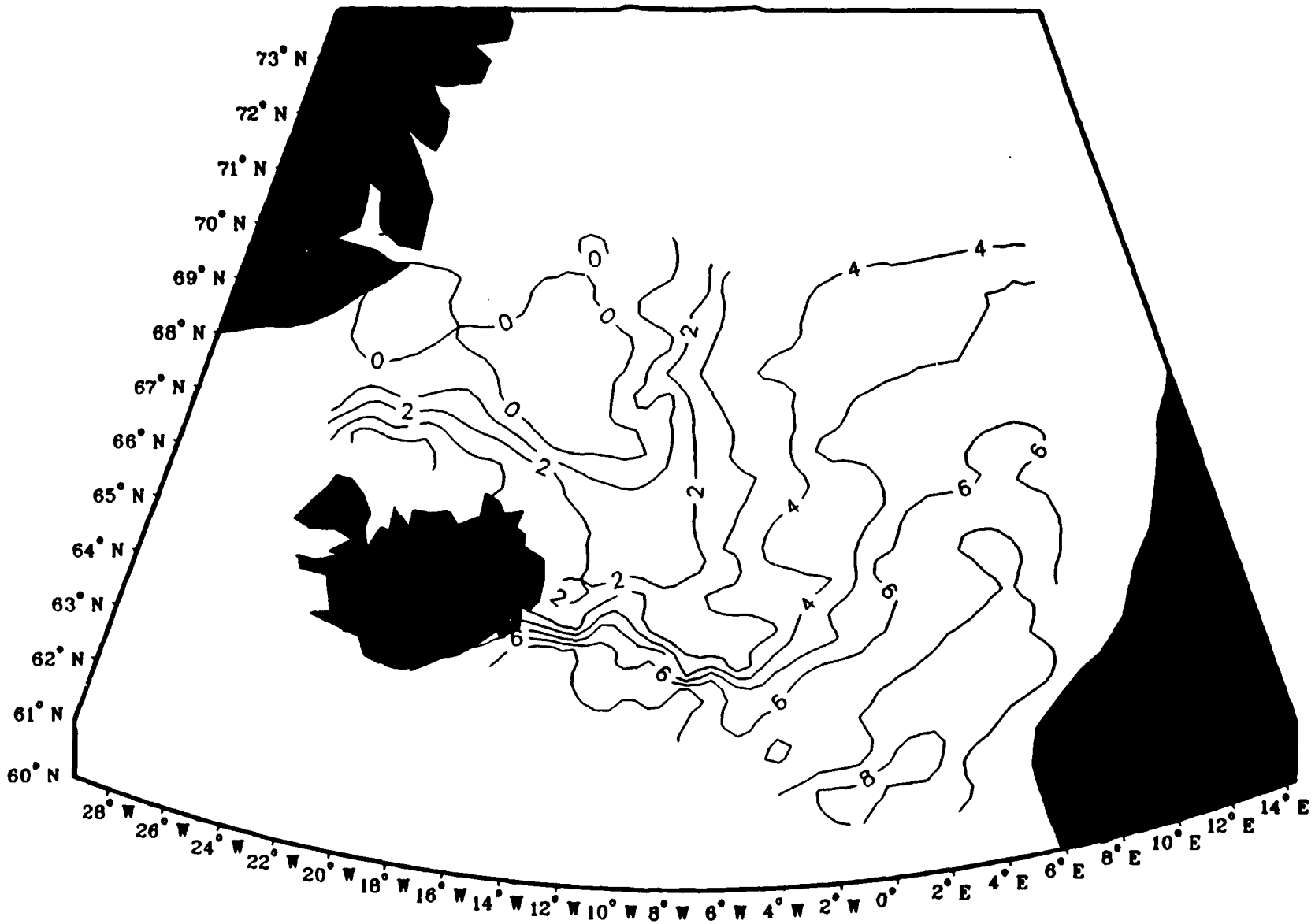

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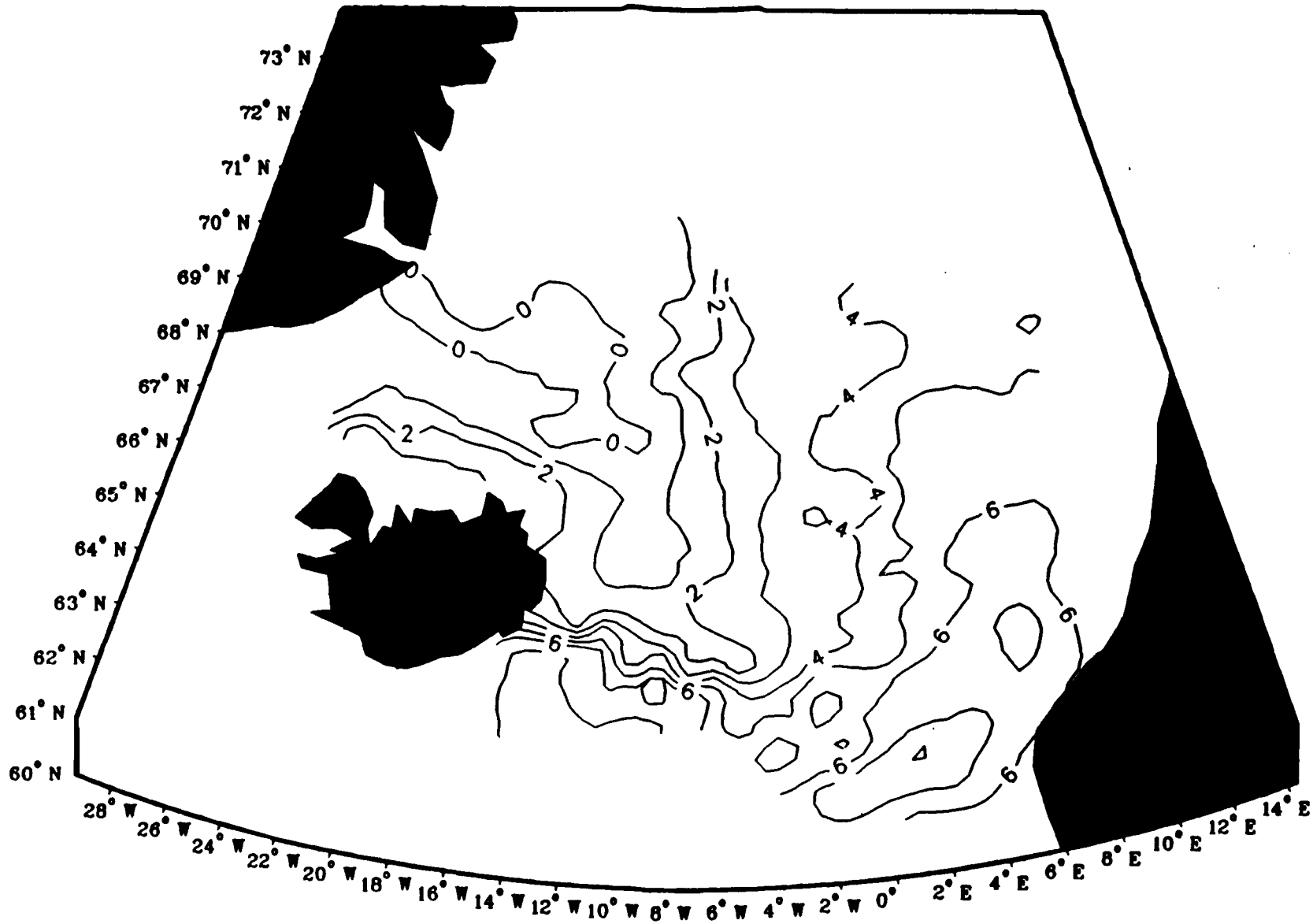

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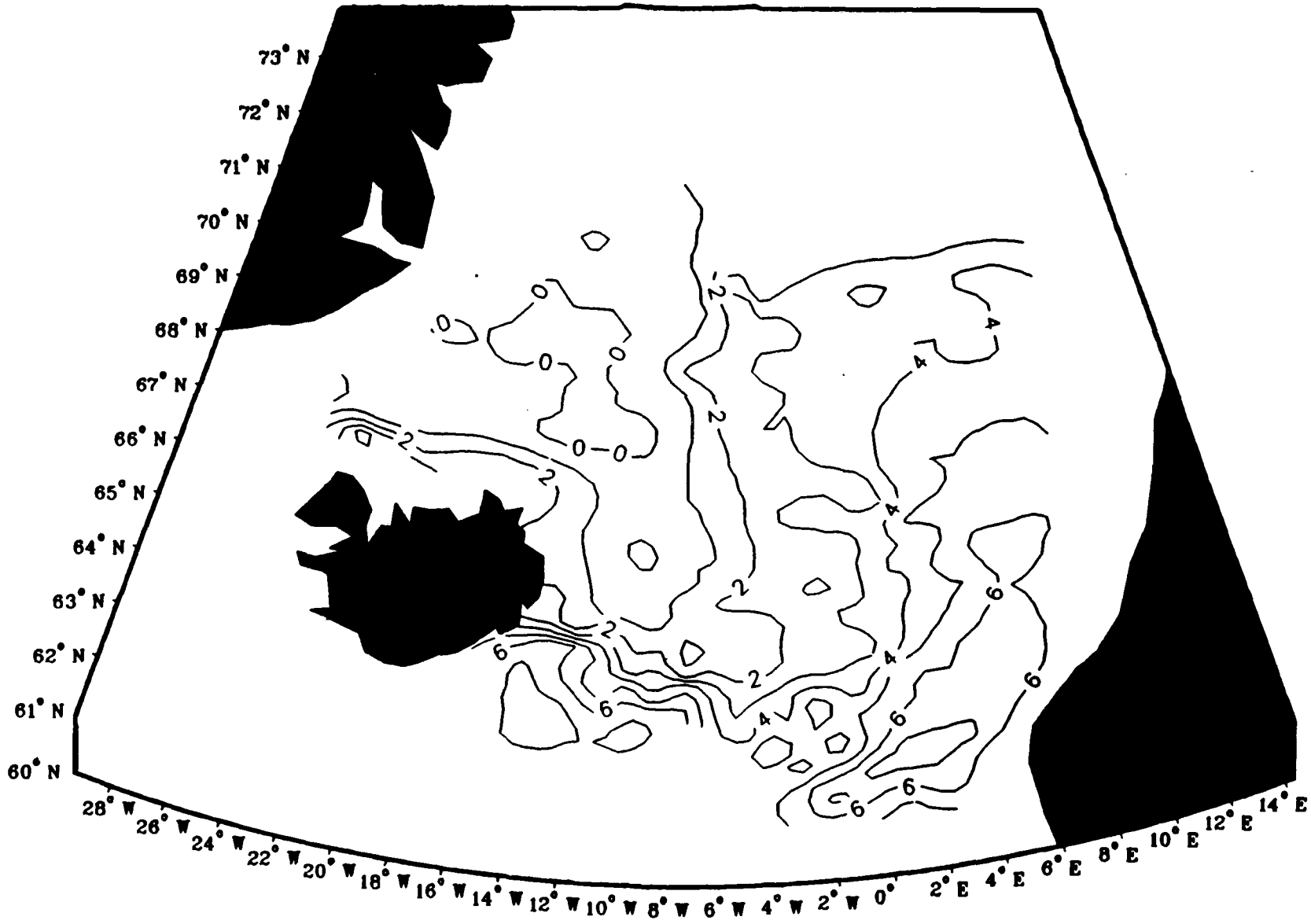

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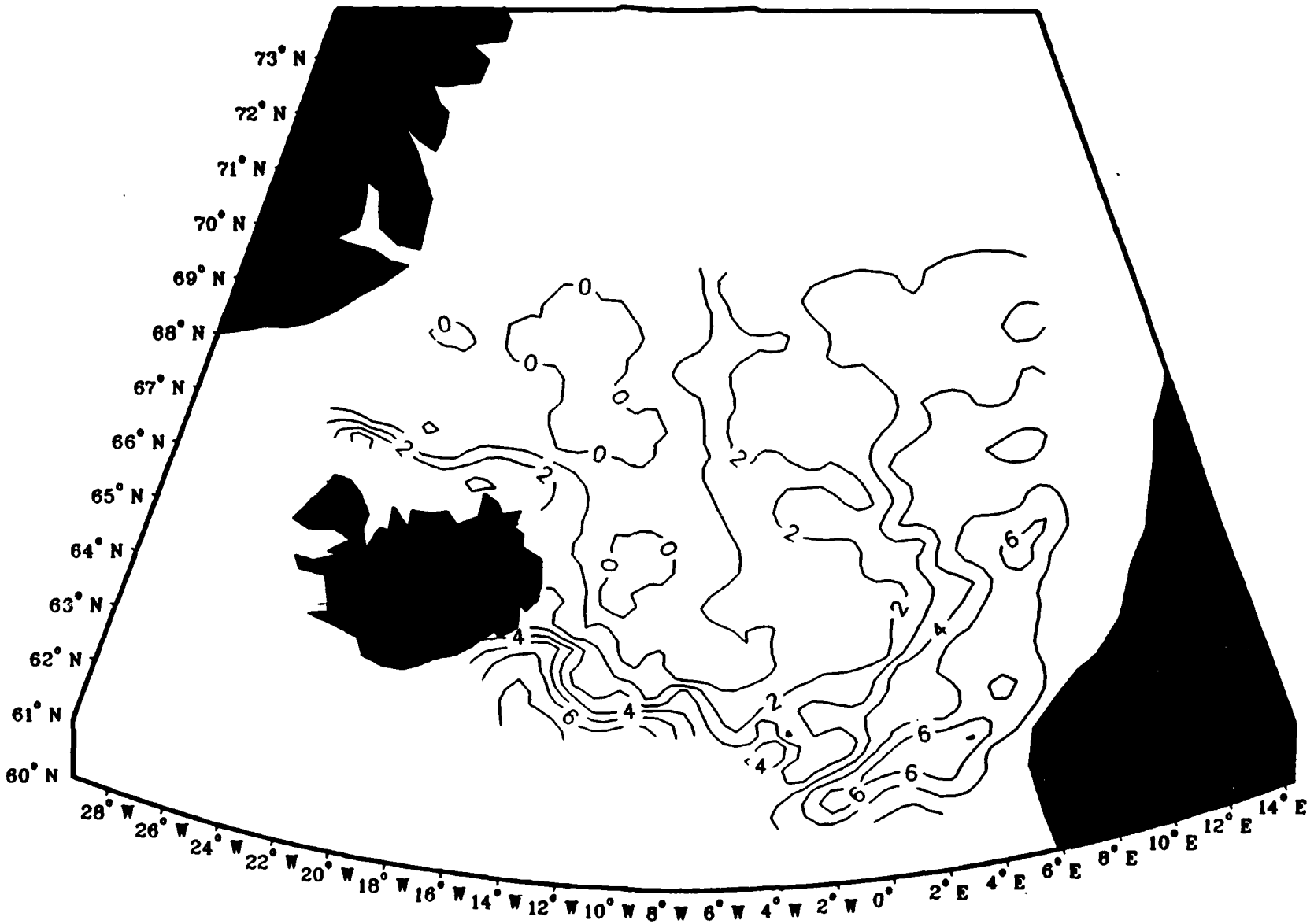

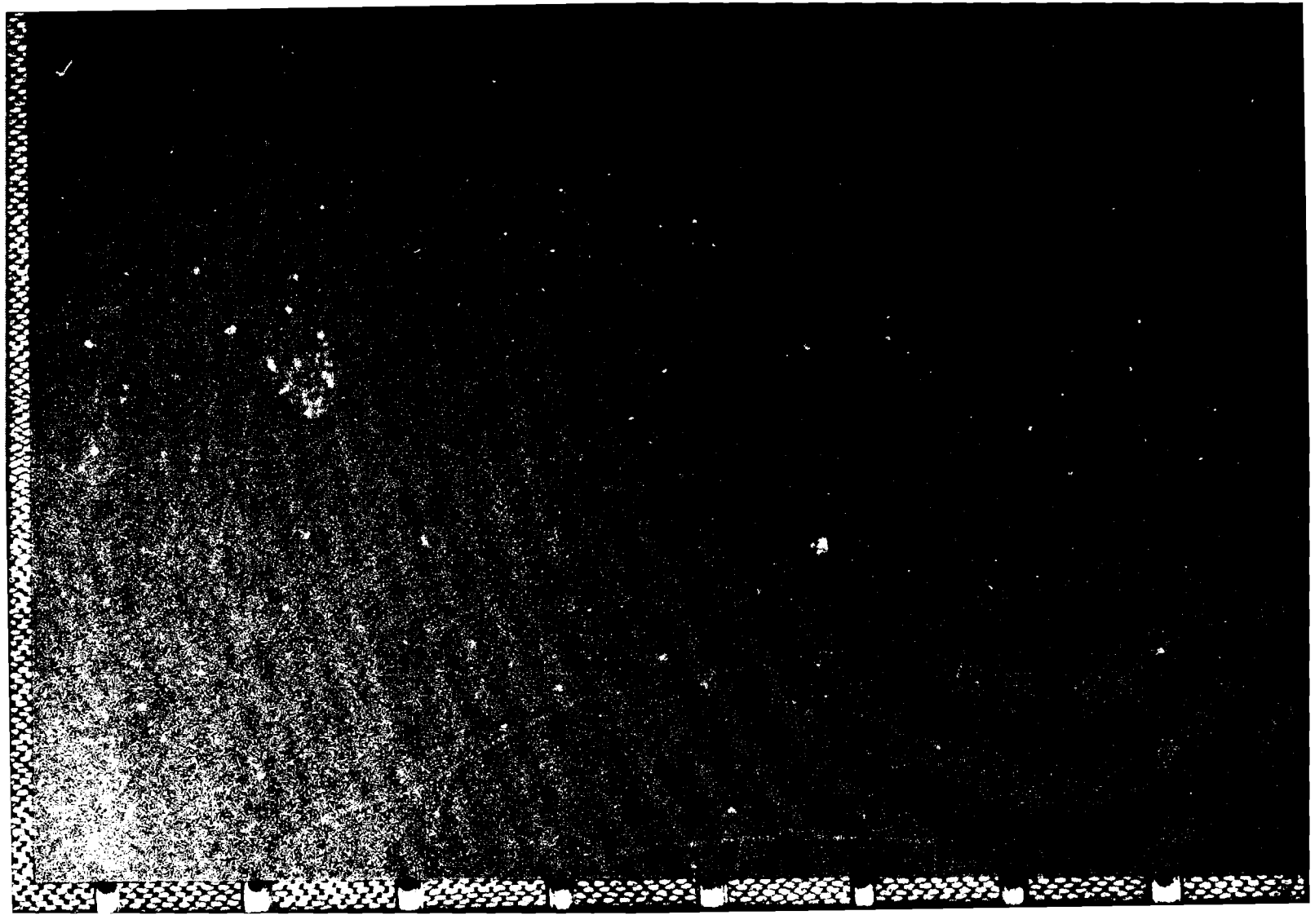

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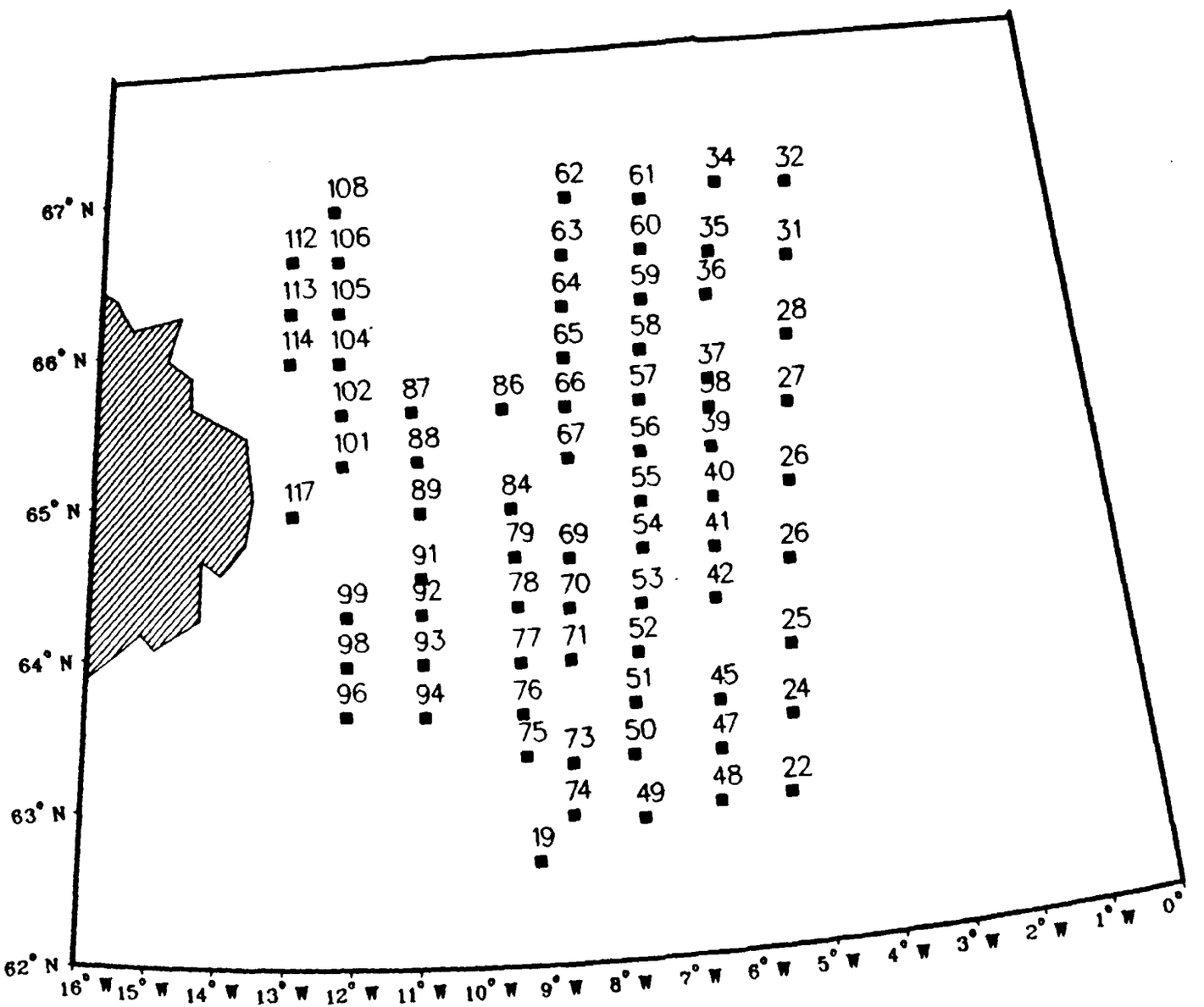

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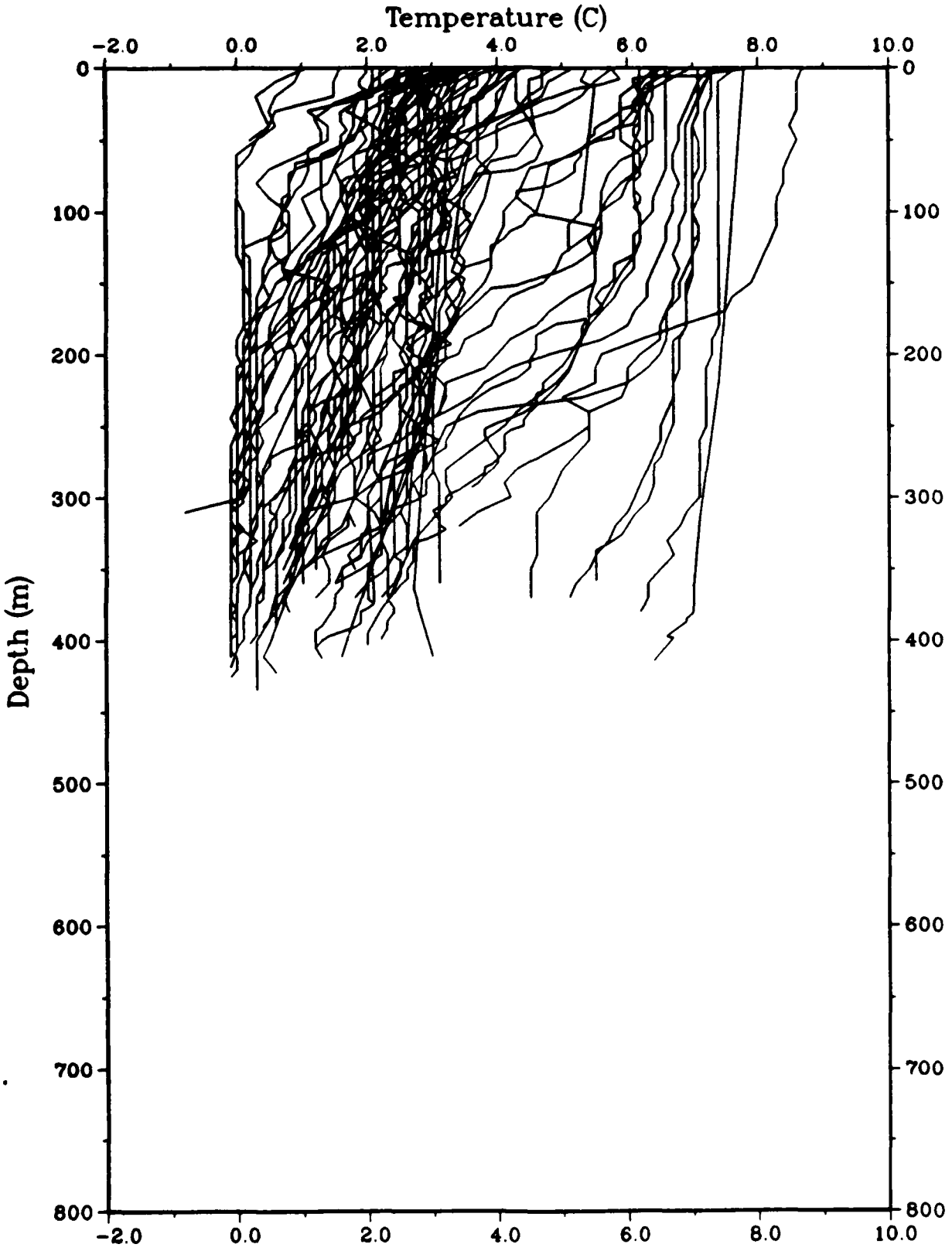
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15 May 1987
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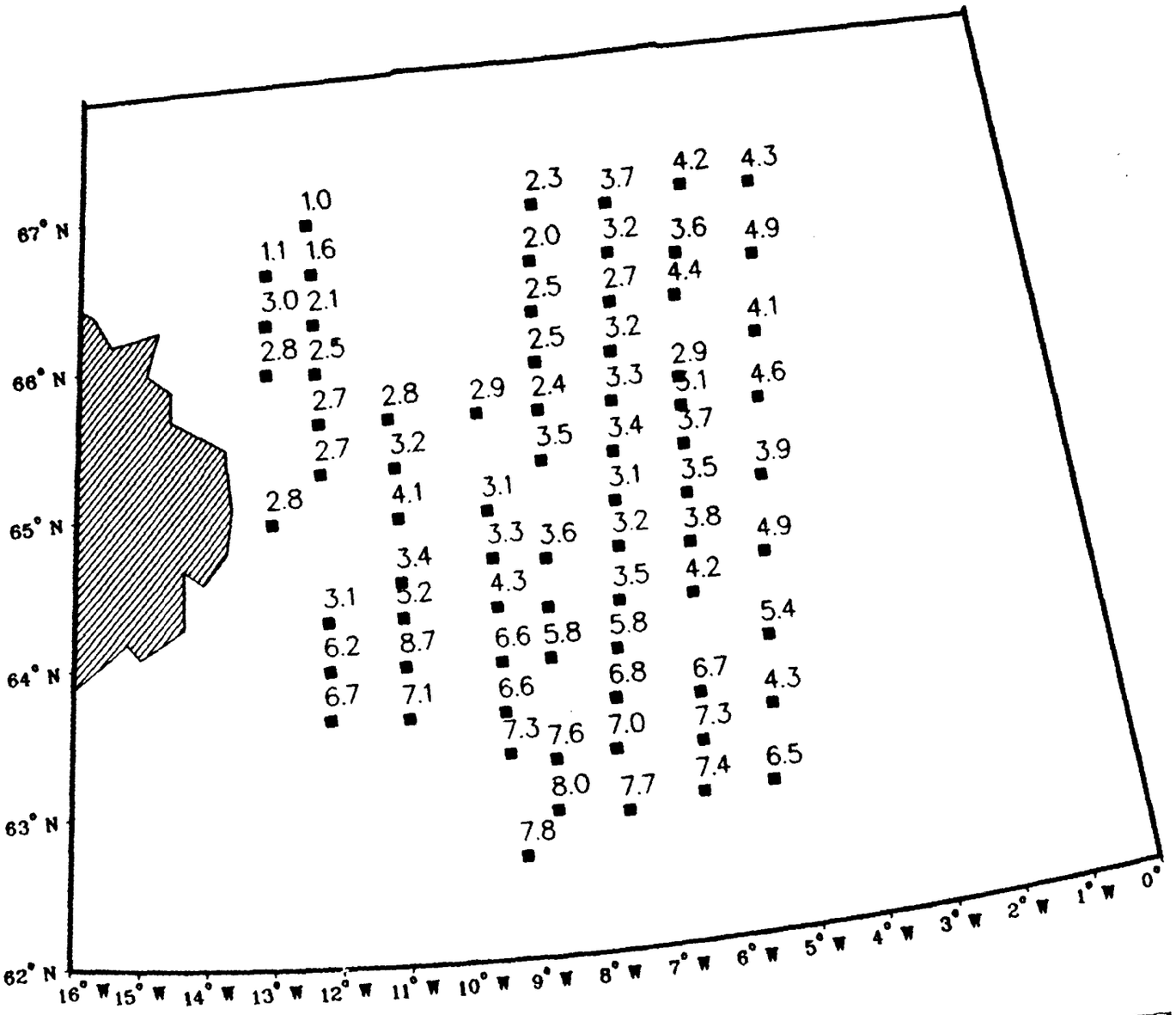

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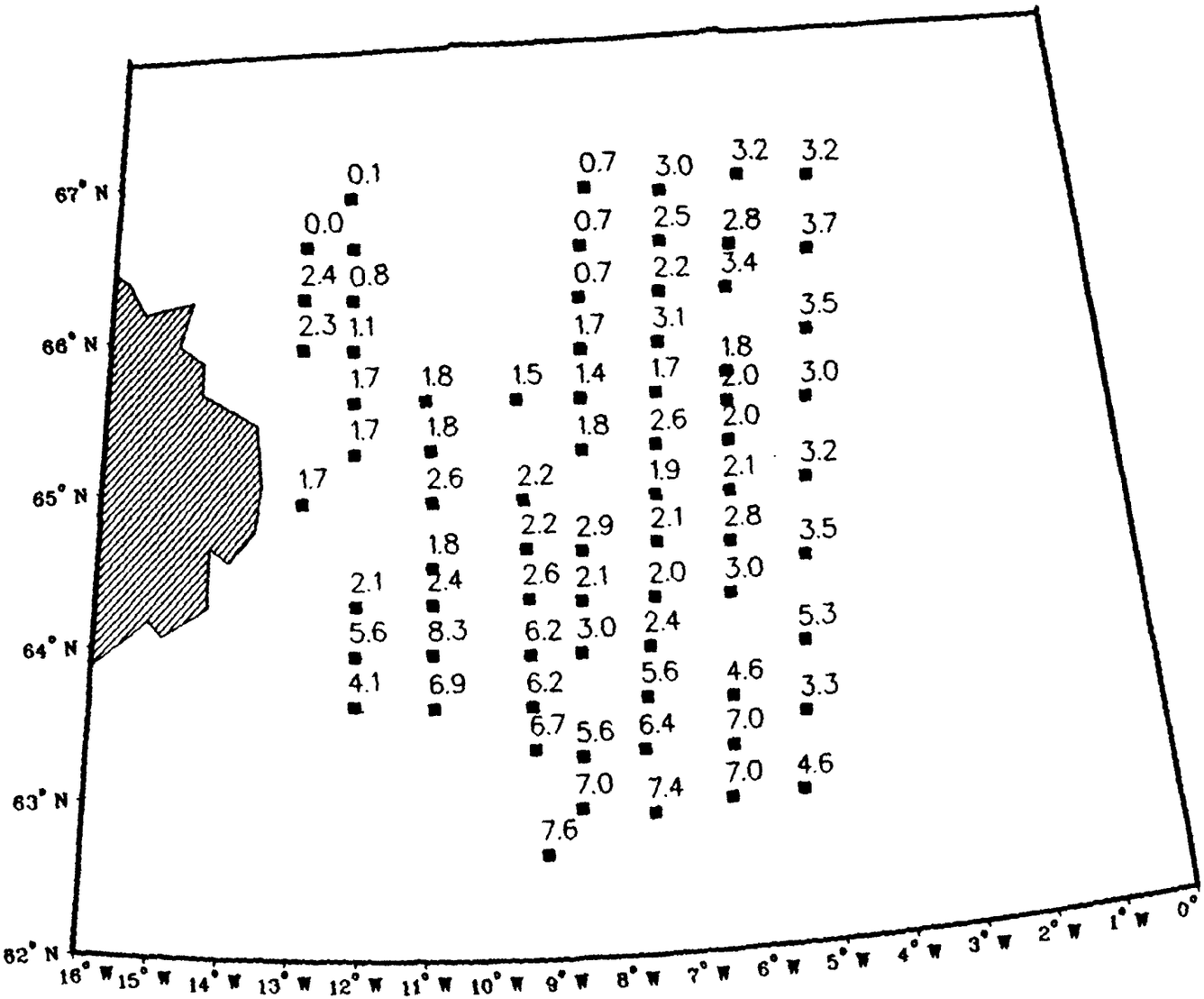

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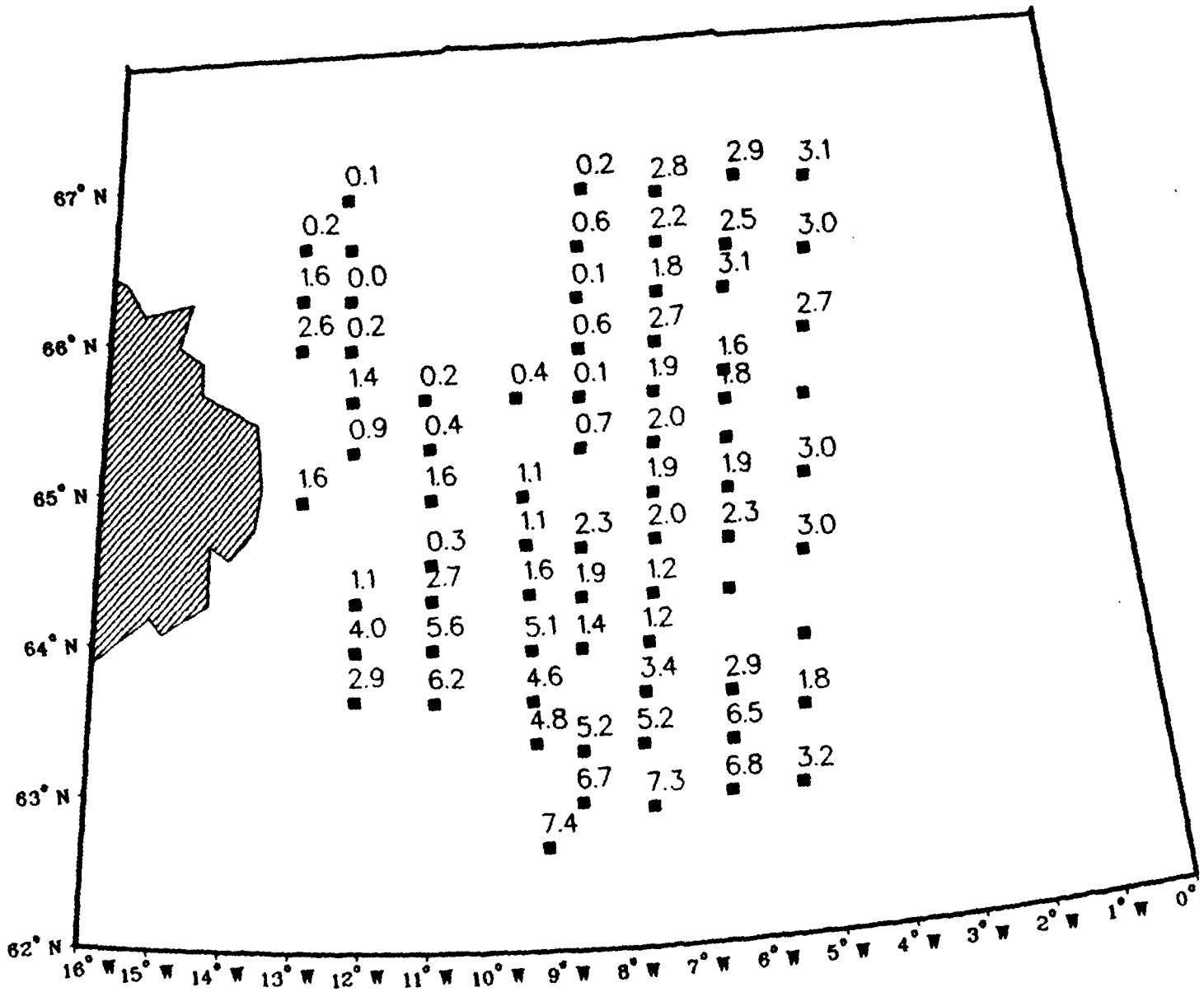

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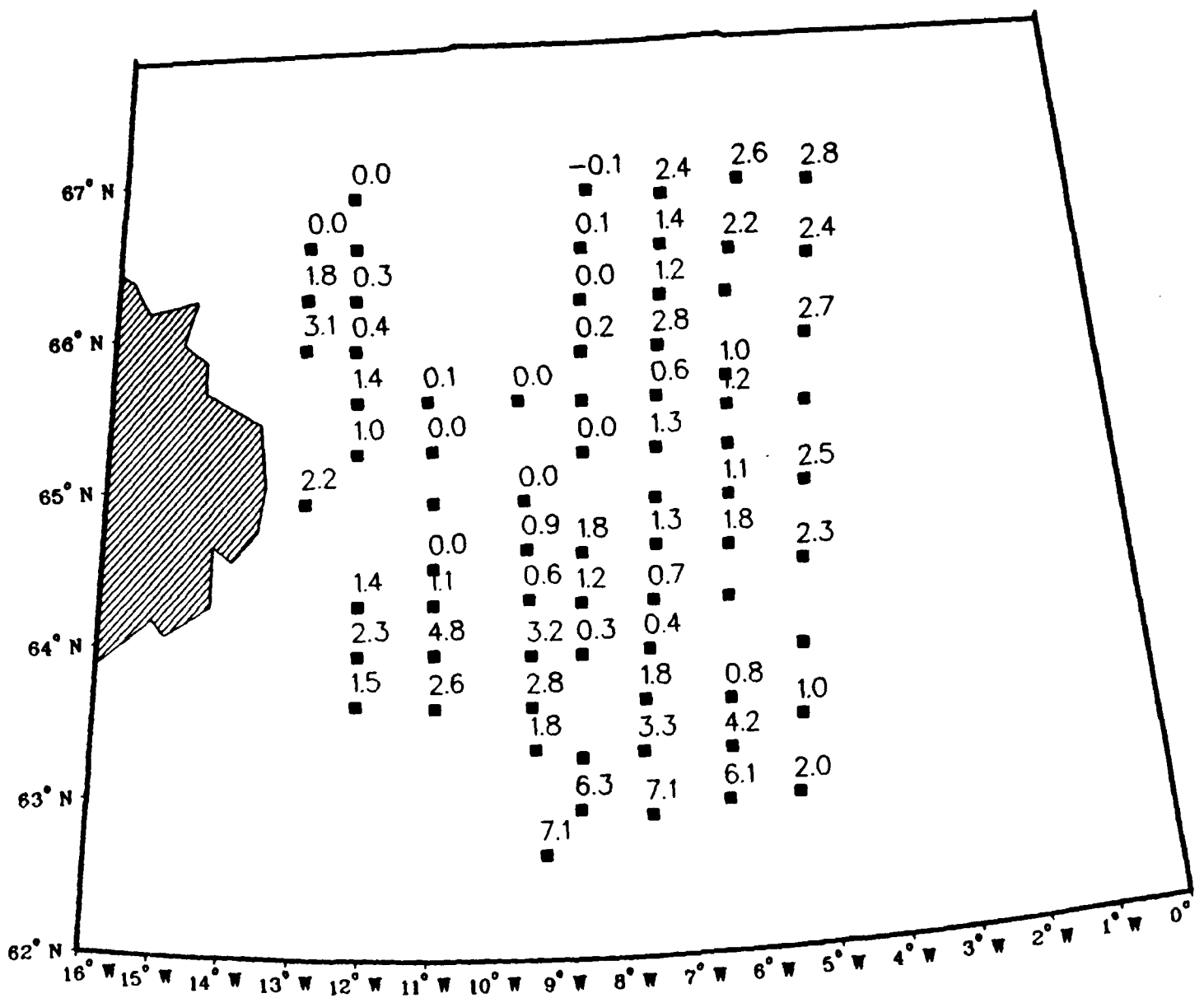

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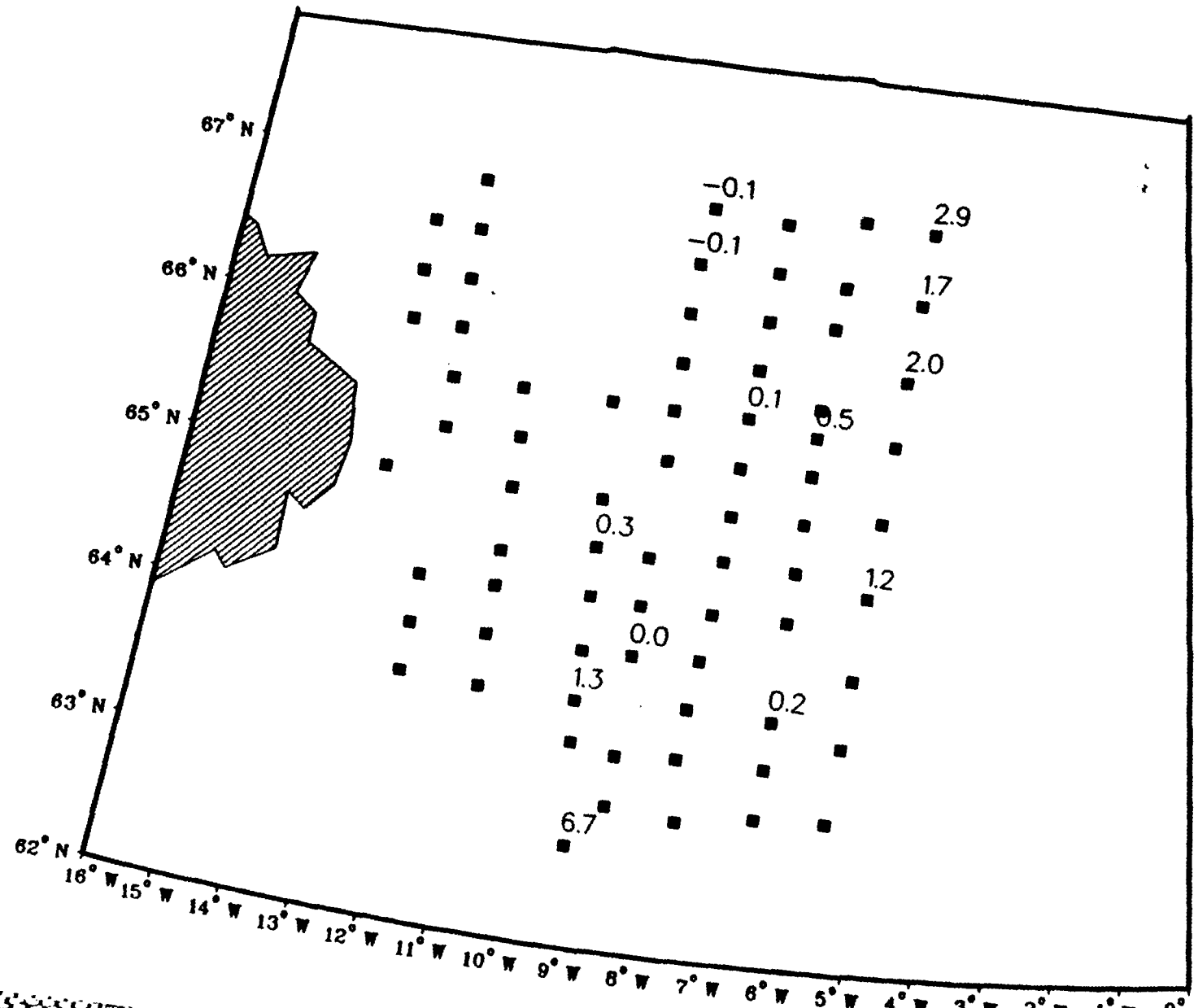

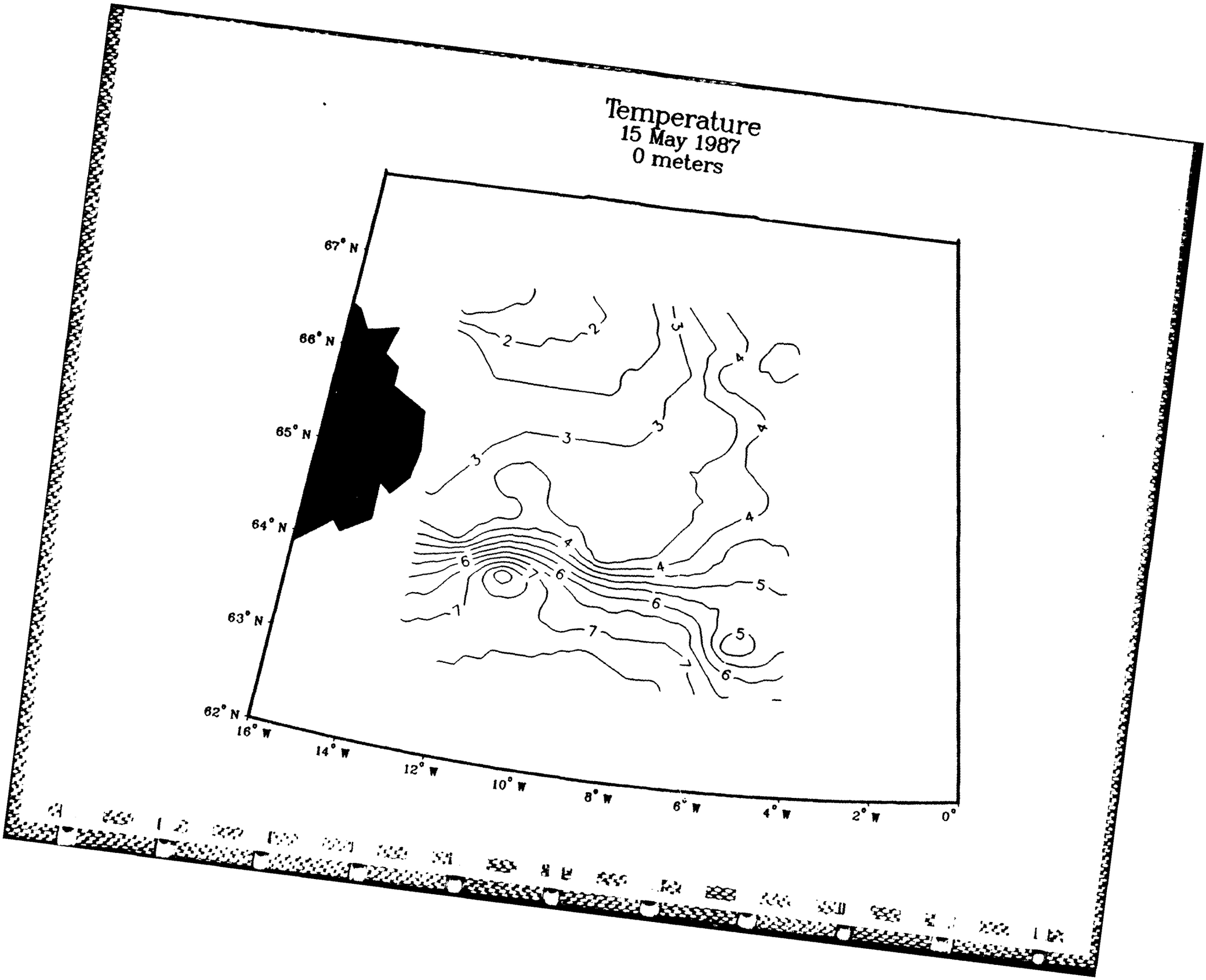
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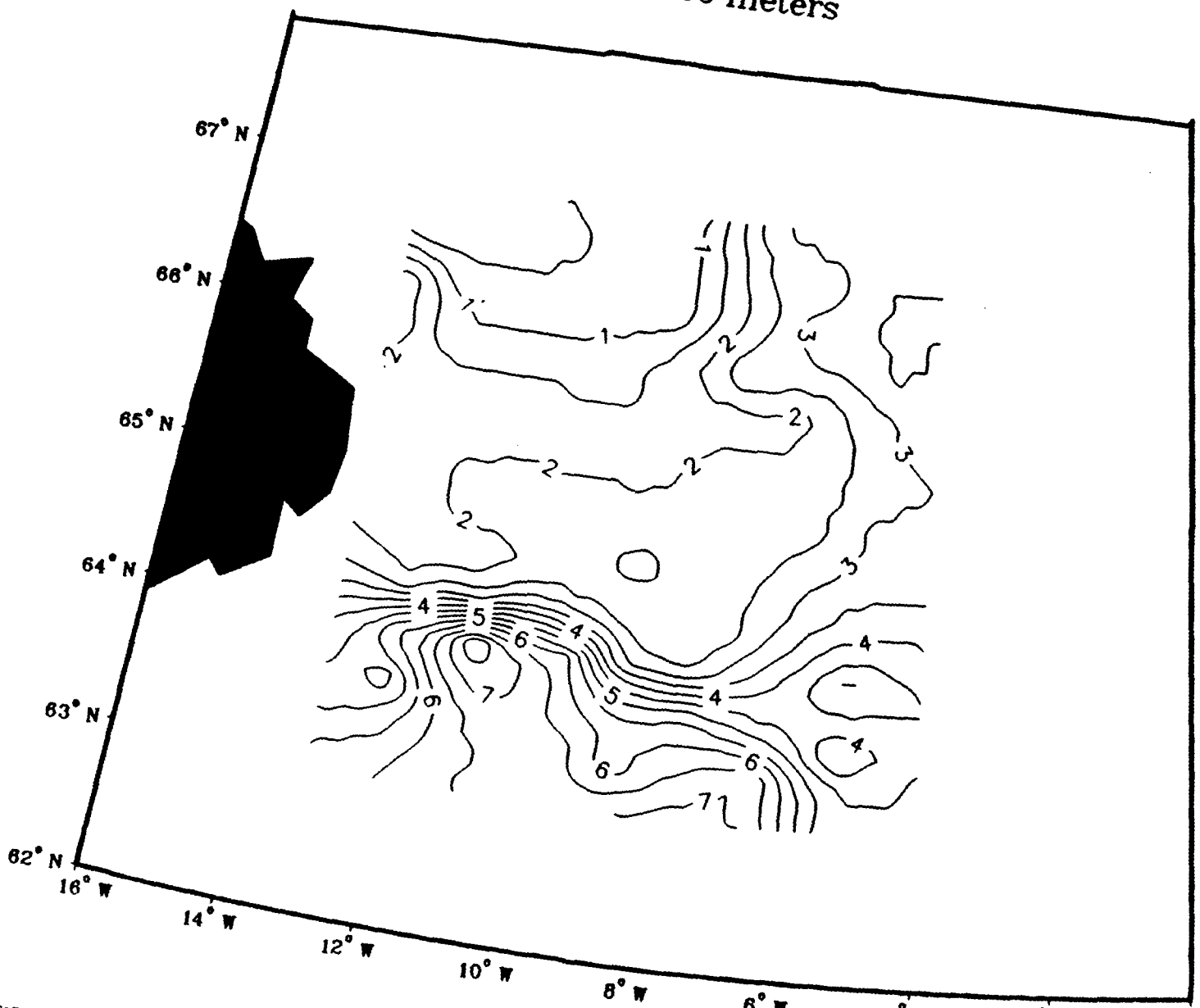

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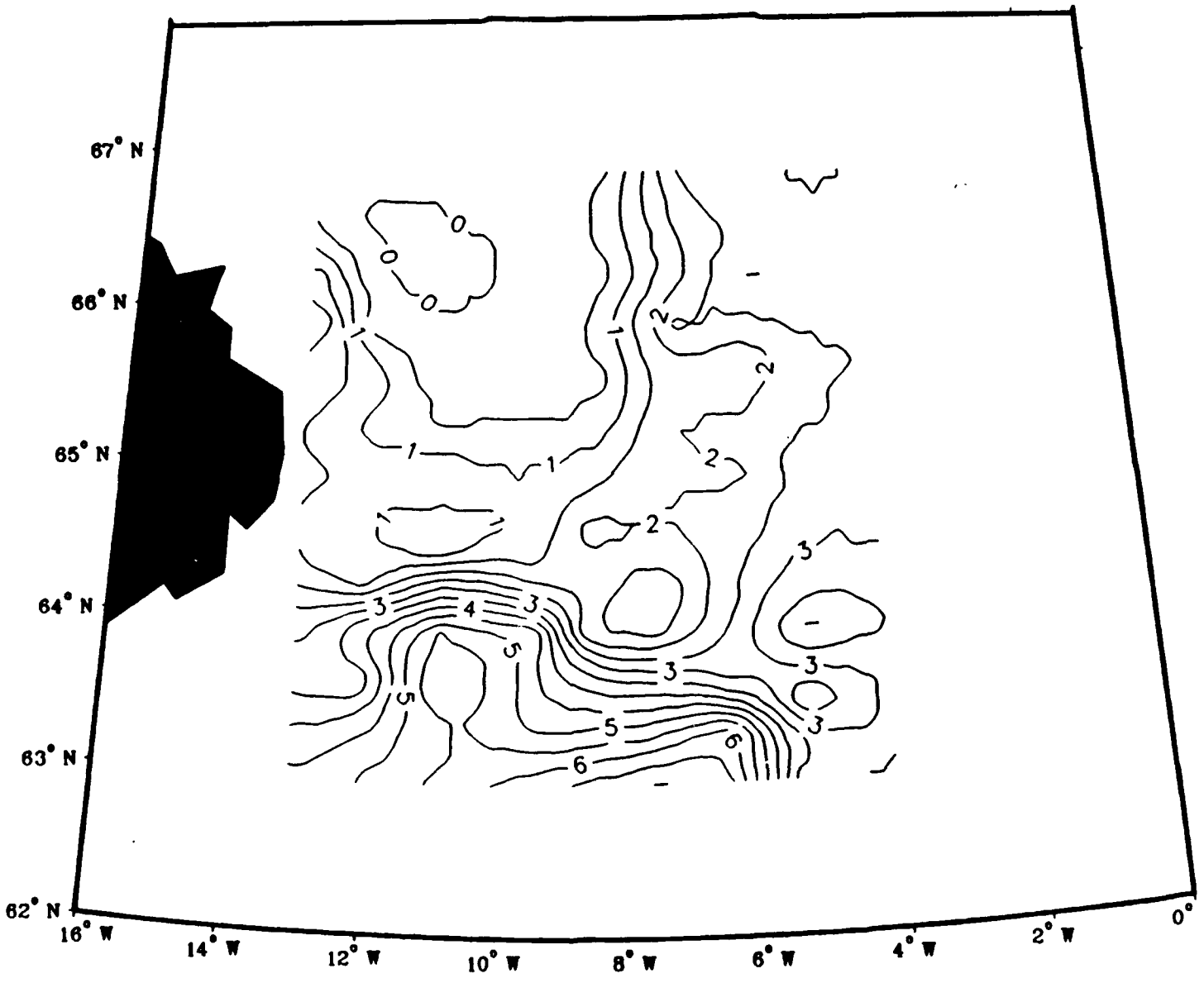

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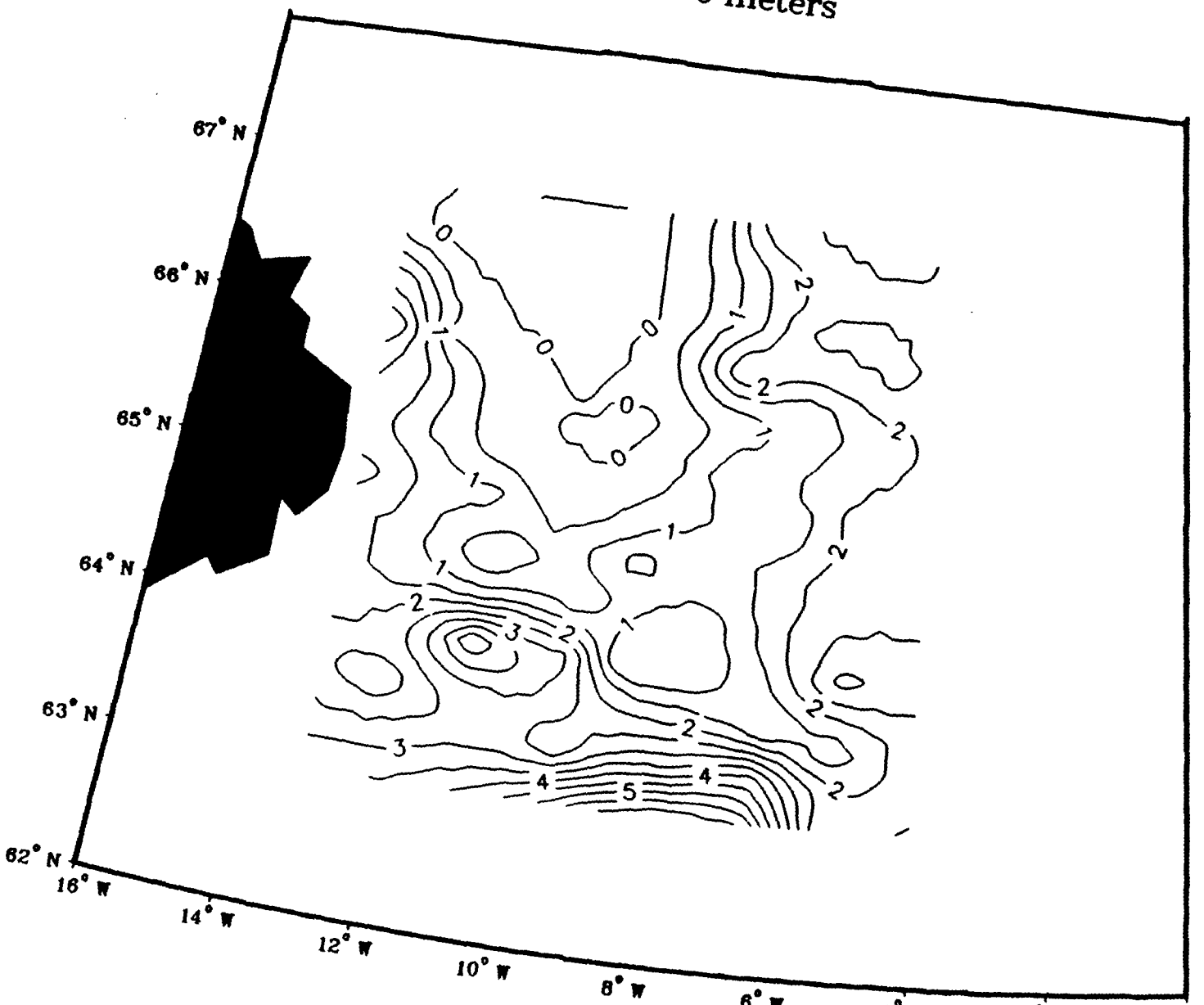

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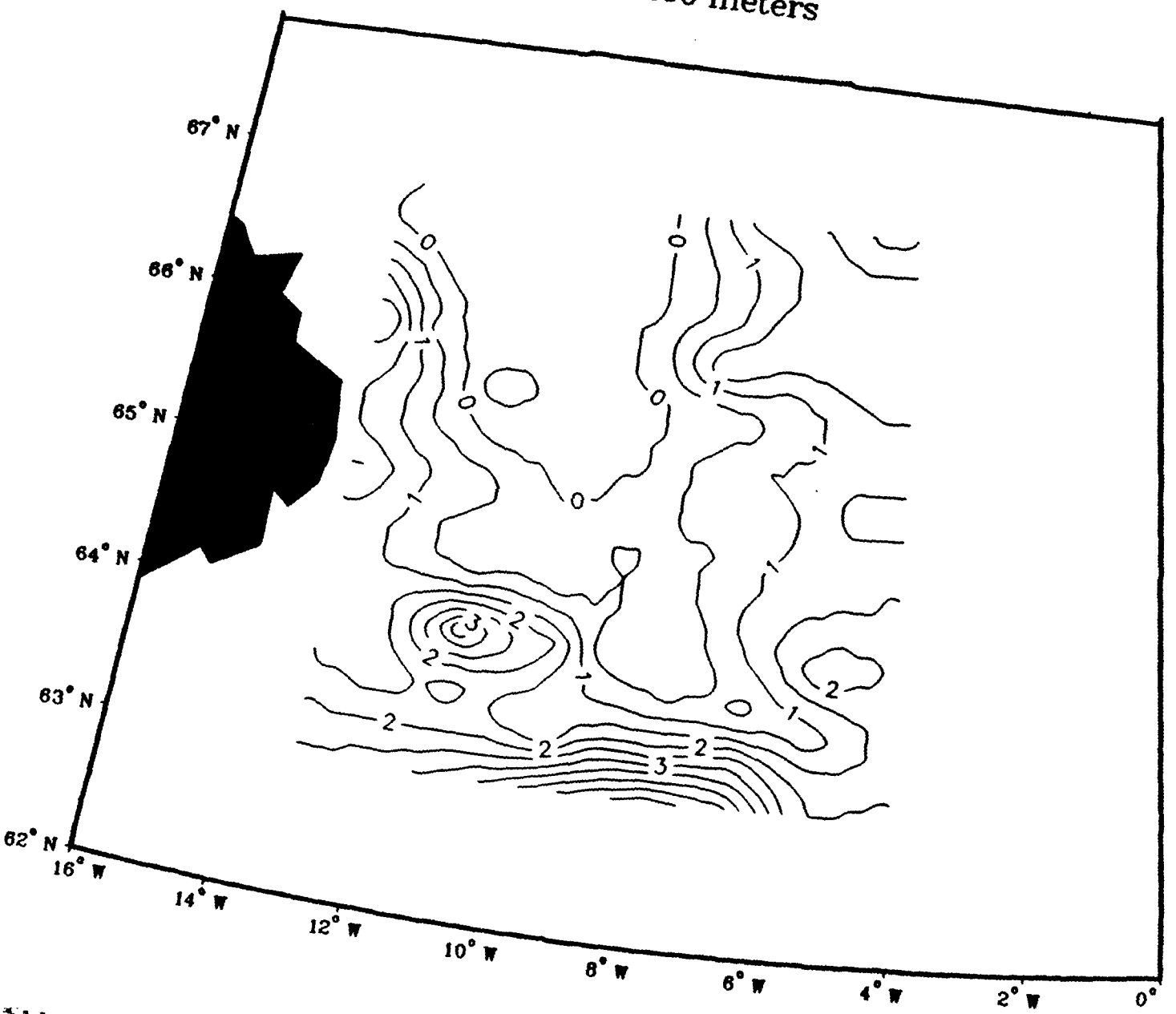
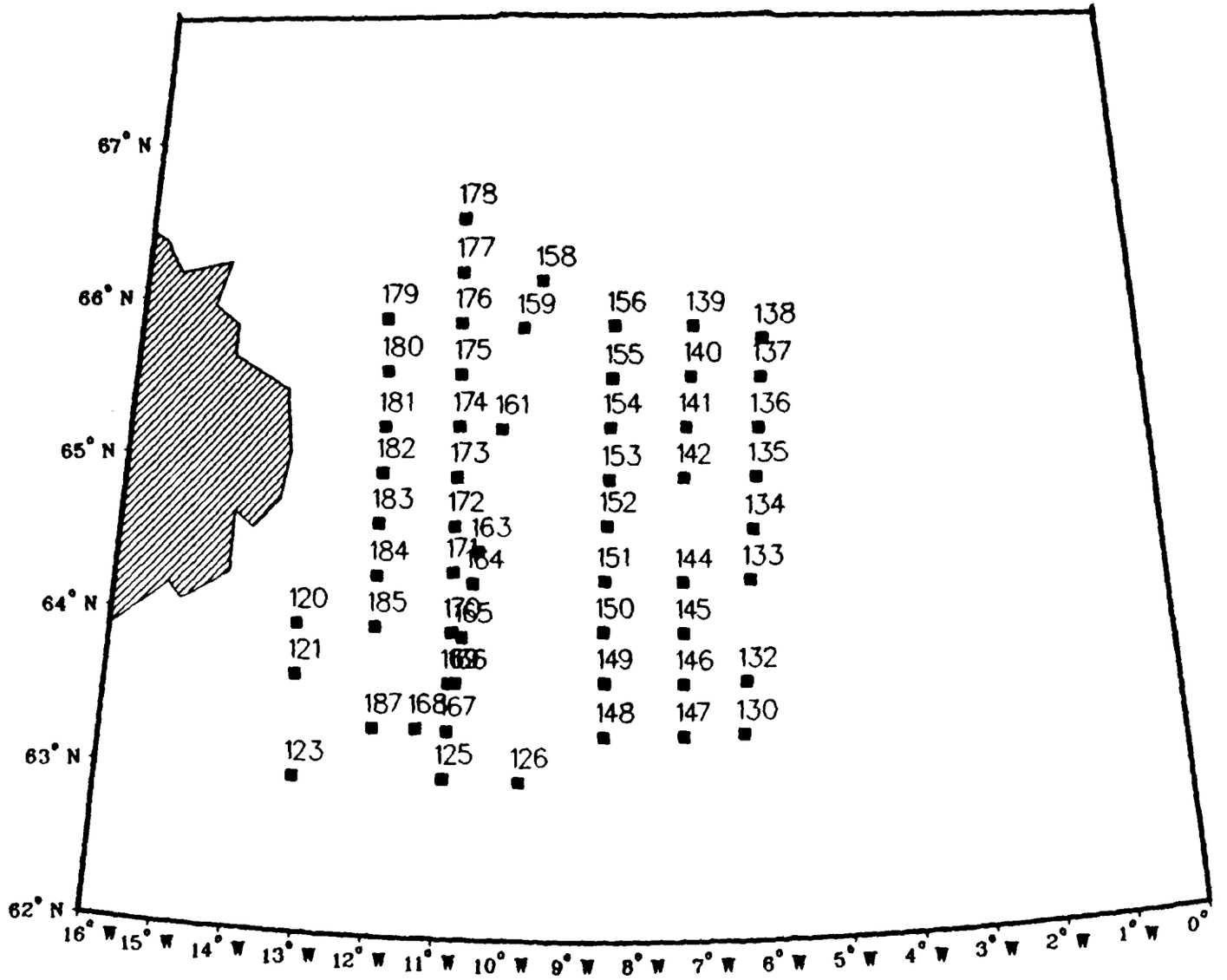


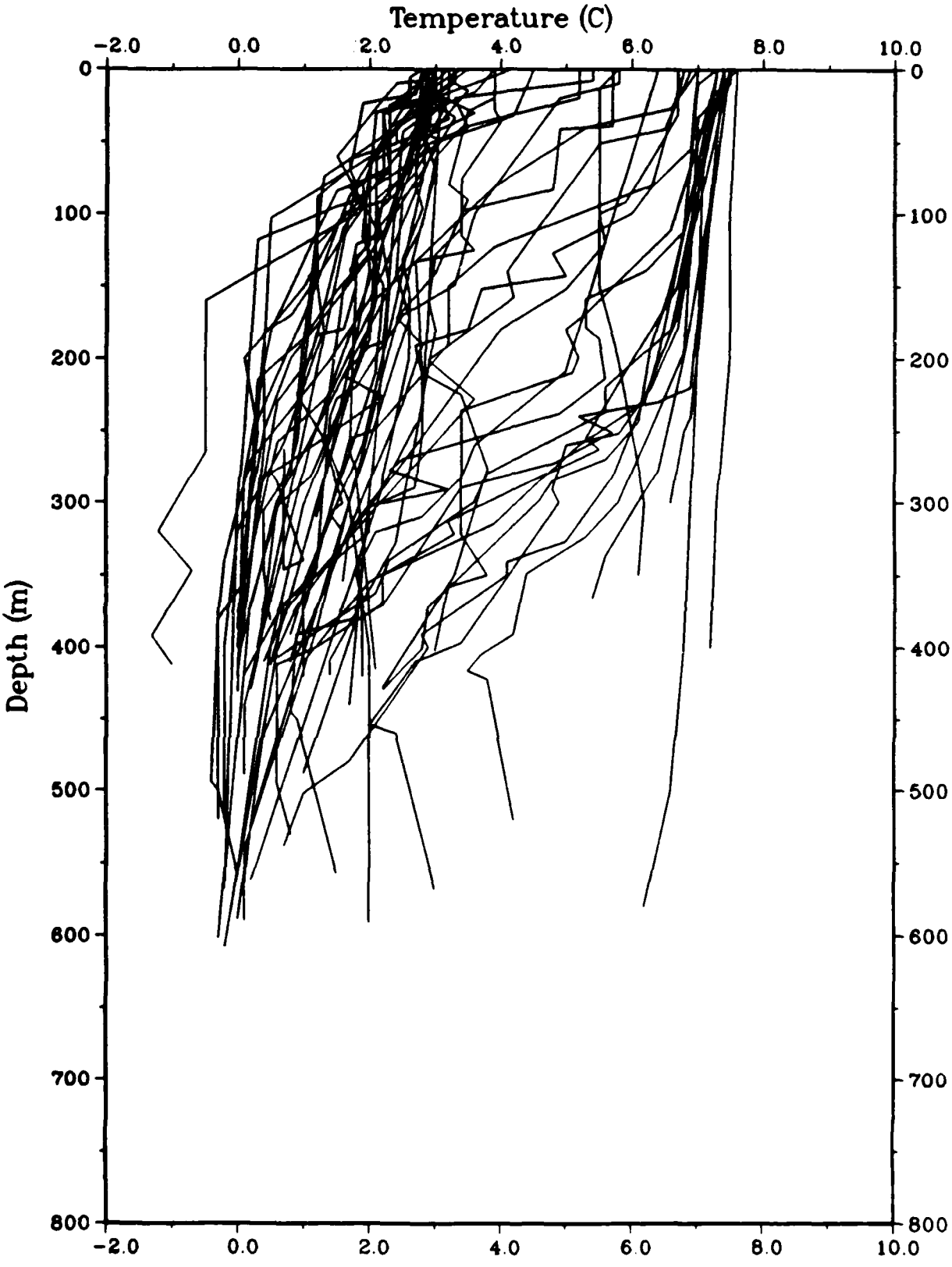
Iceland-Faeroe Frontal Zone
Survey #2

18 May 1987

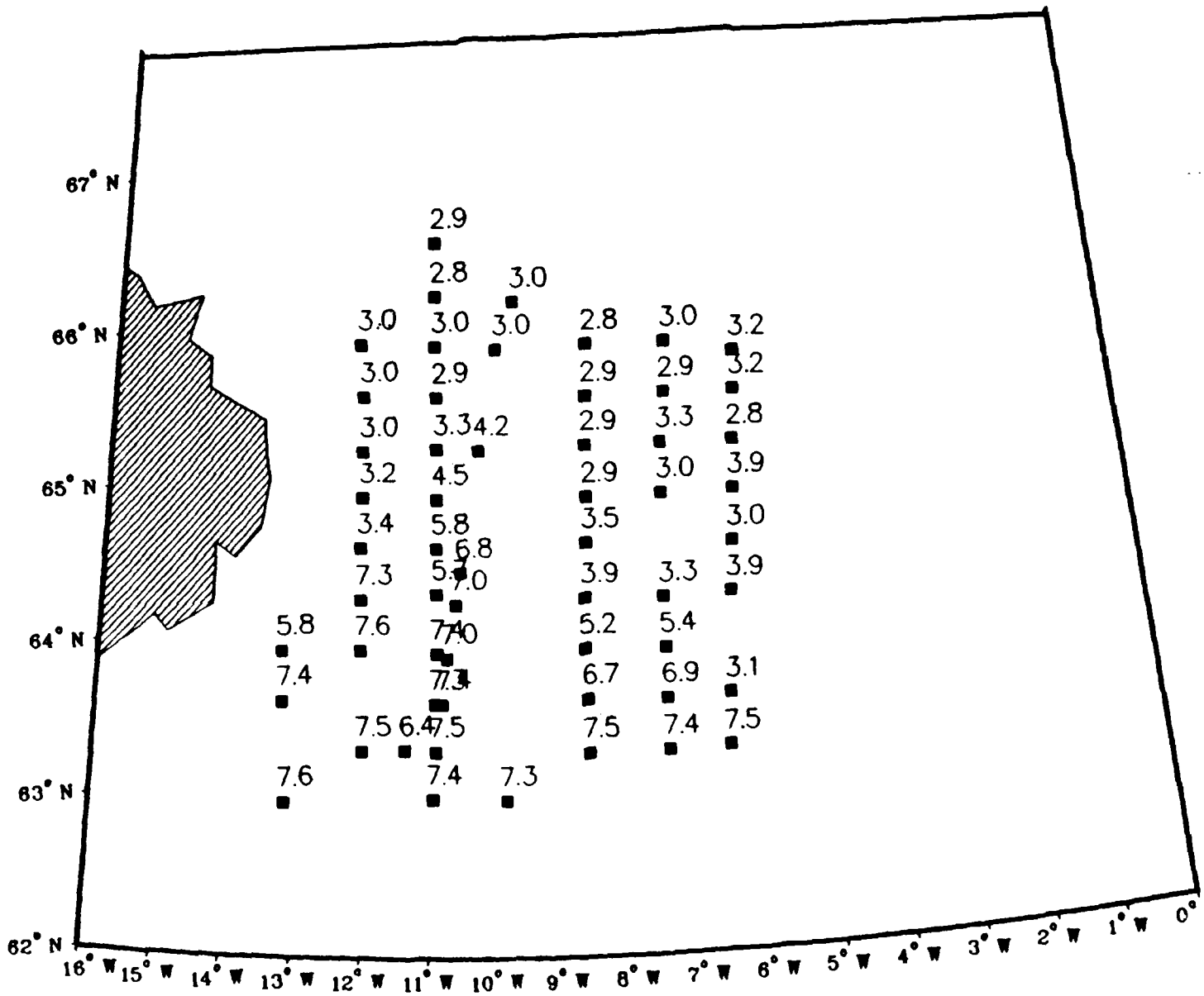
18 May 1987
AXBT Stations



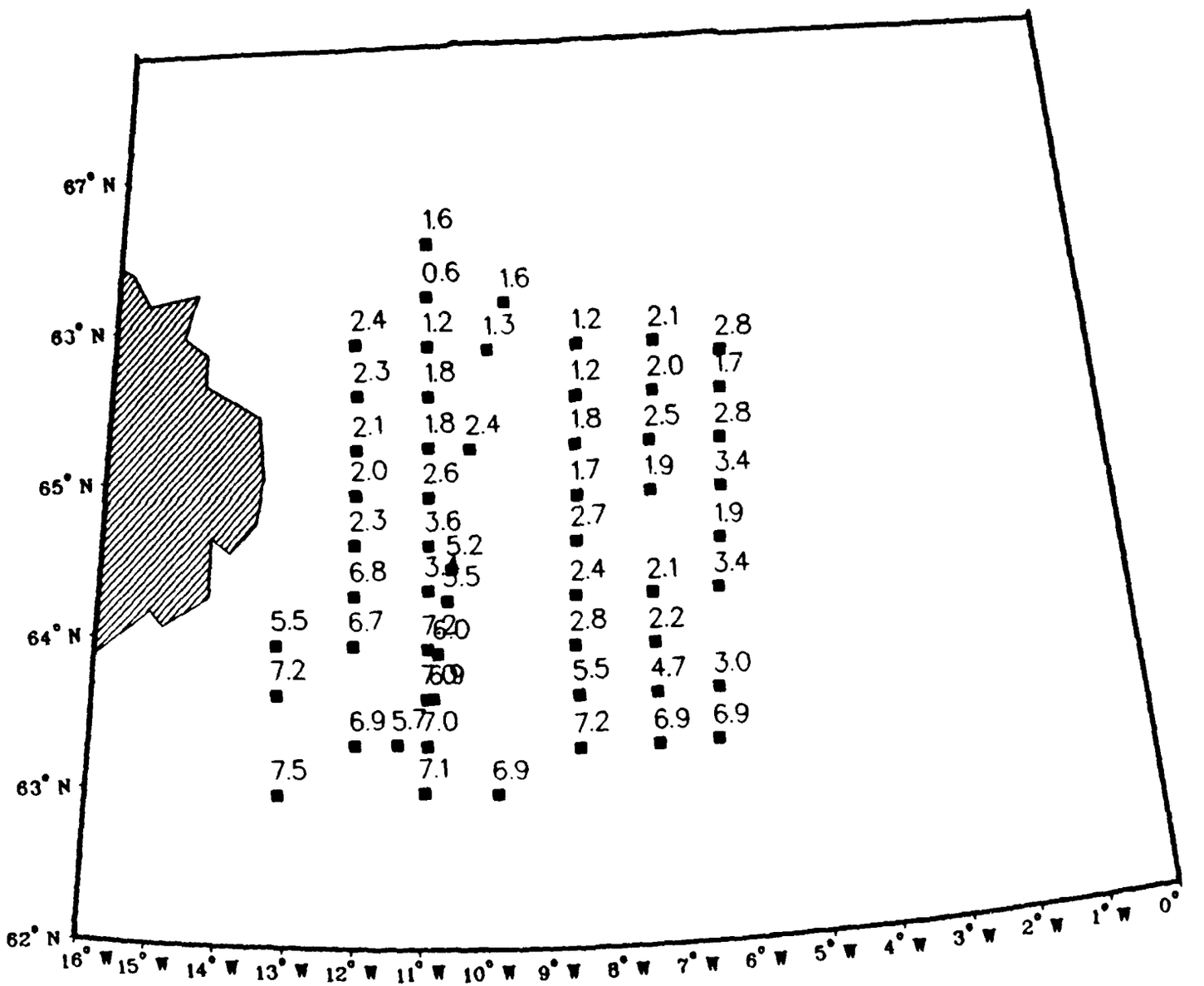
18 May 1987


Temperature (C)
-2.0
0.0
2.0
4.0
6.0
8.0
10.0
Depth (m)
0
100
200
300
400
500
600
700
800

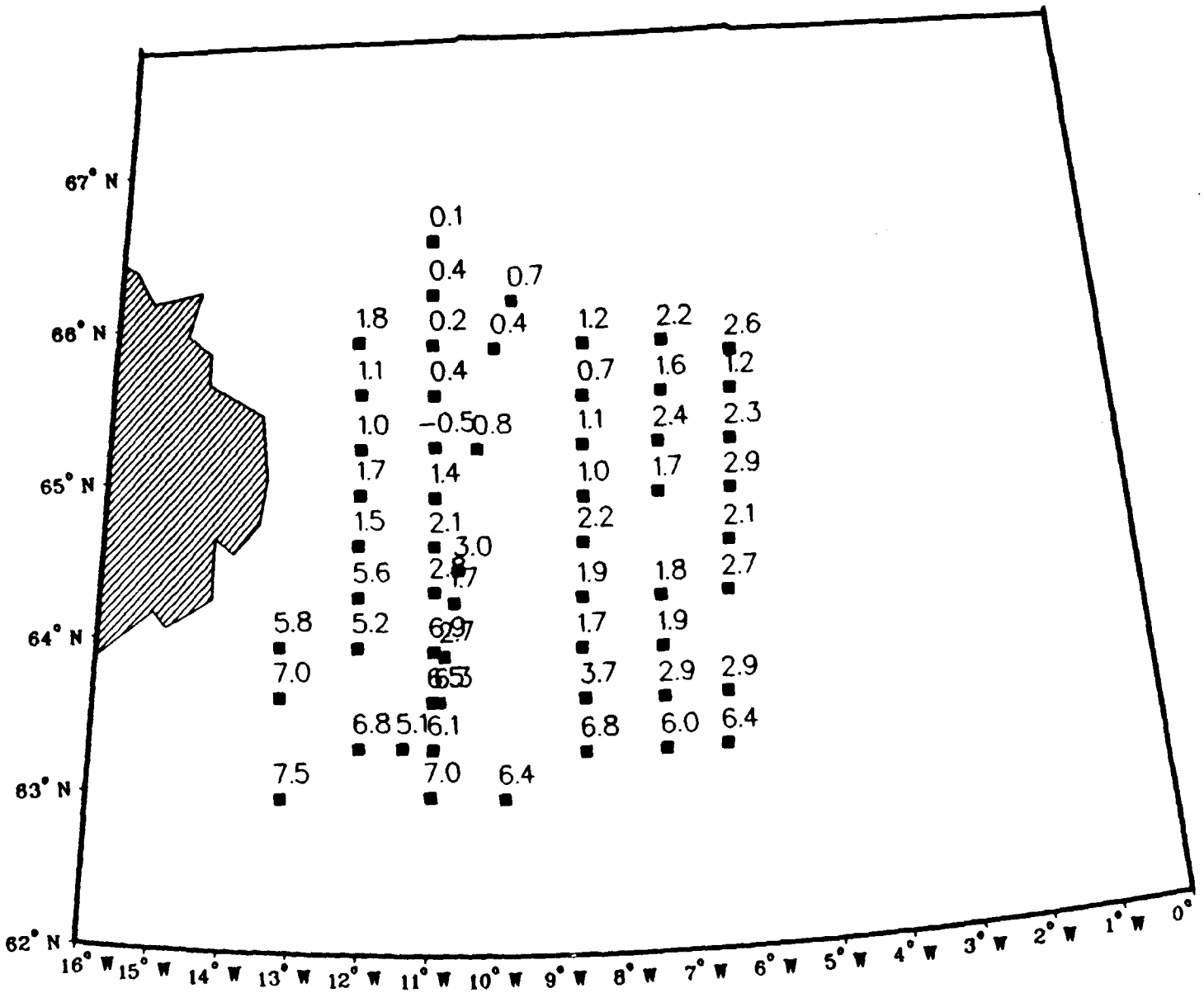
18 May 1987
0 meters



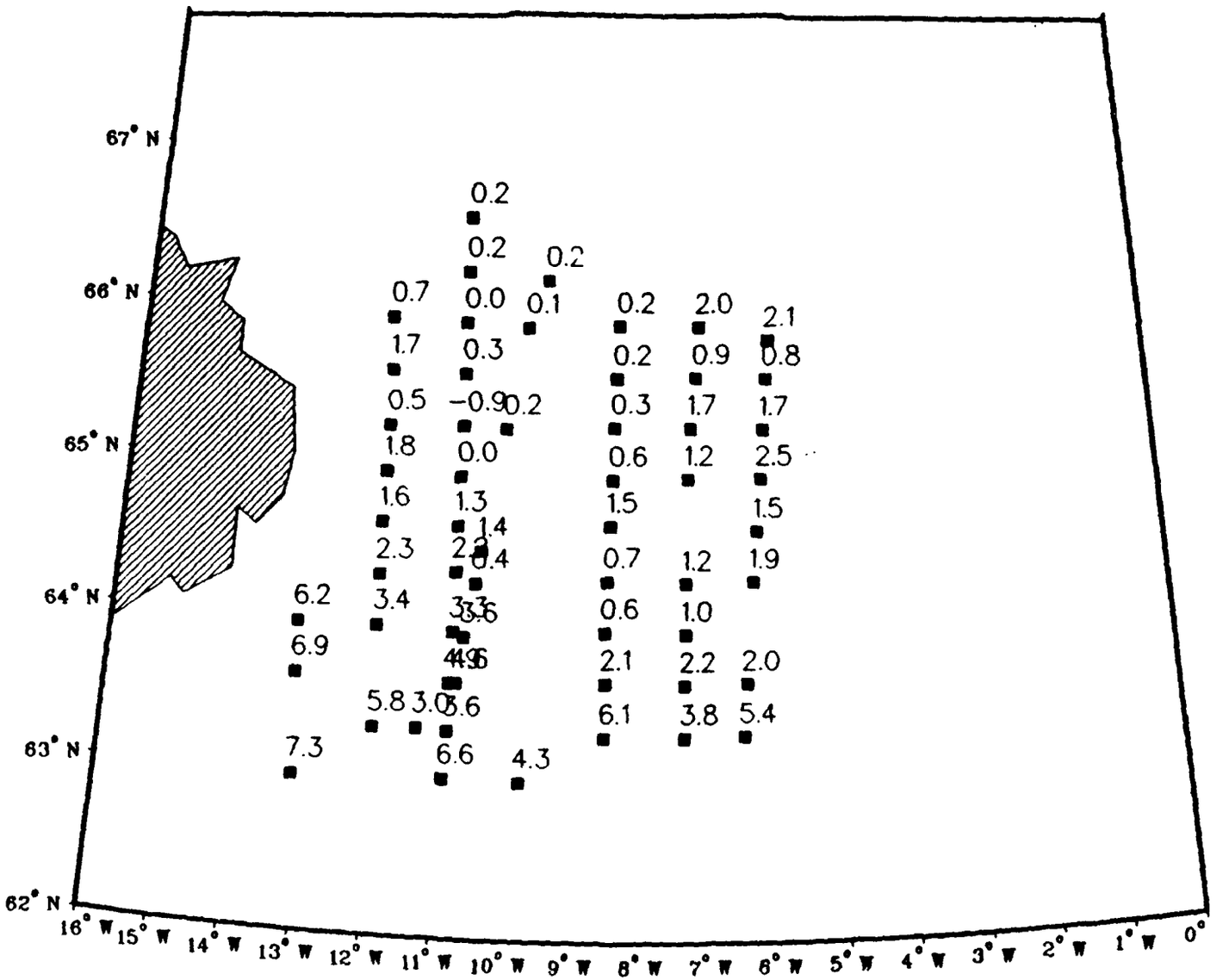
18 May 1987
100 meters



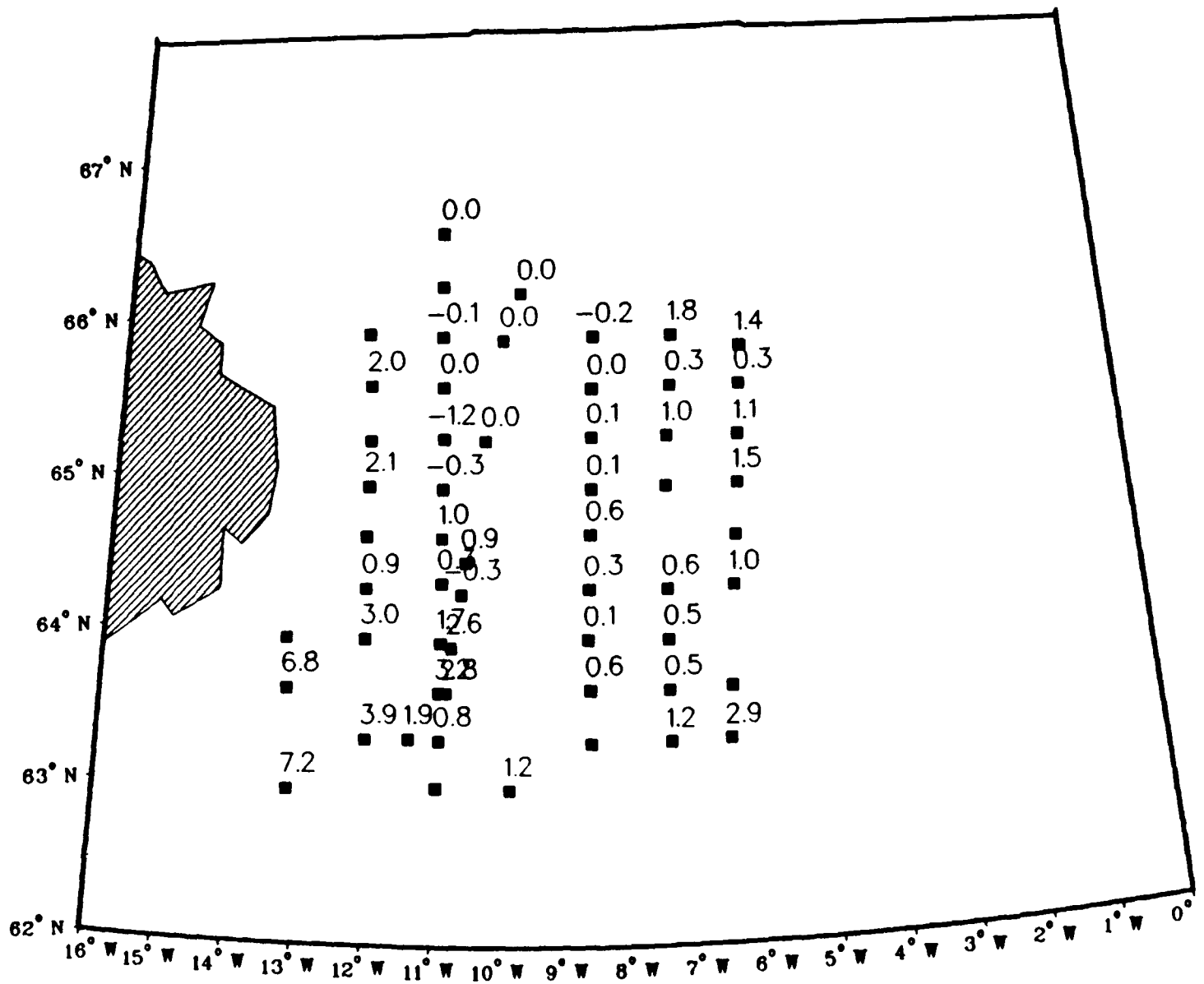
18 May 1987
200 meters

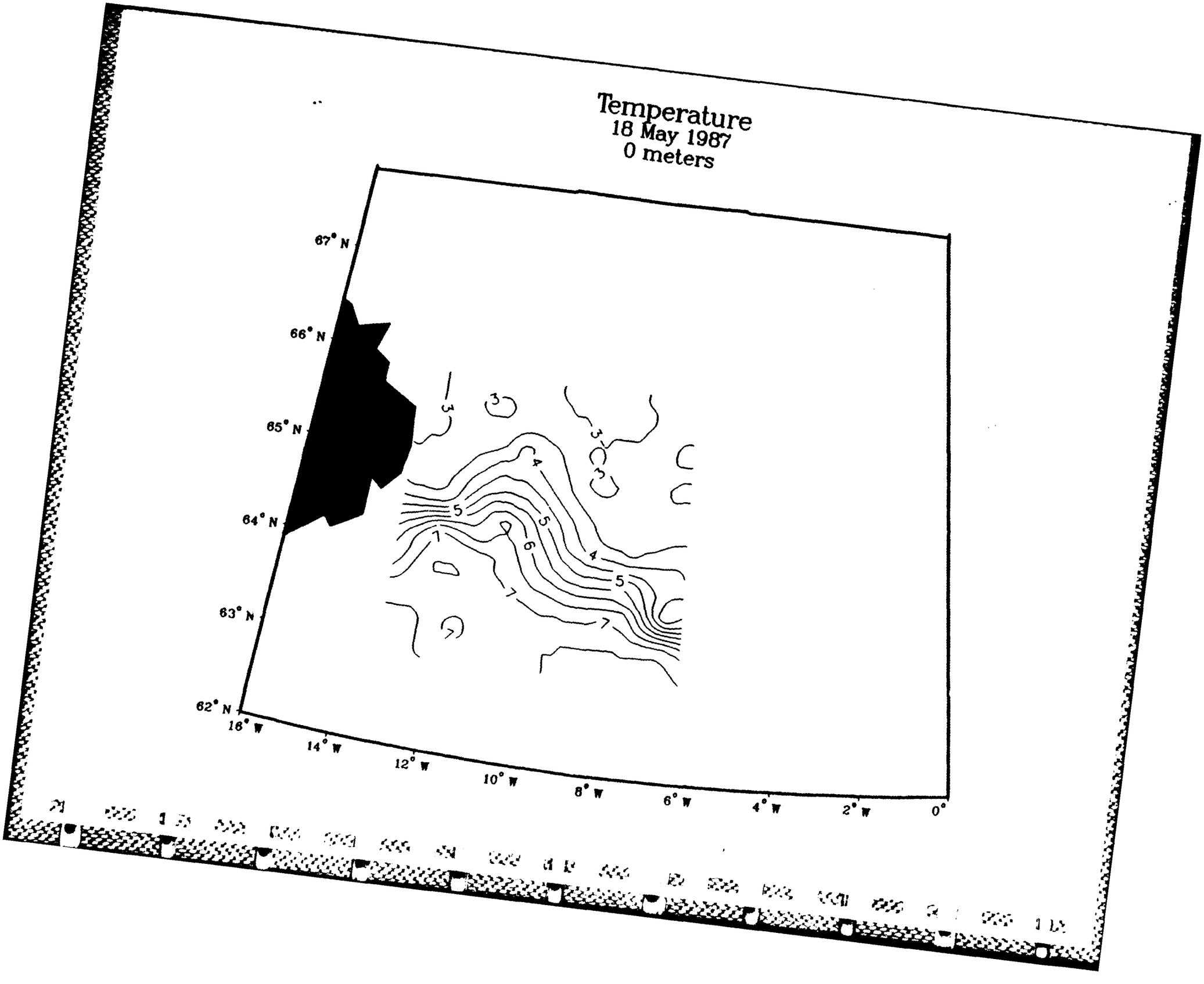


18 May 1987
300 meters

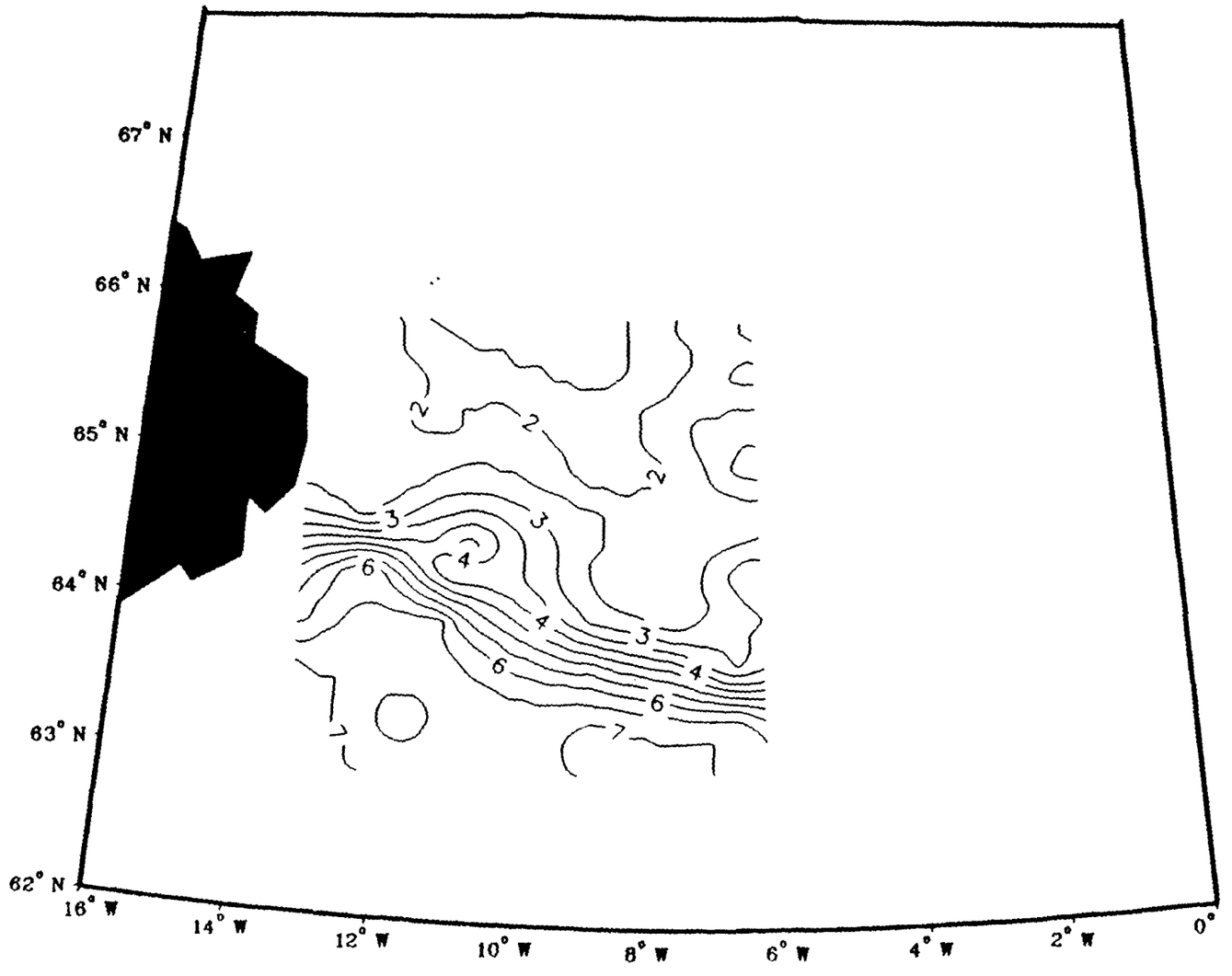


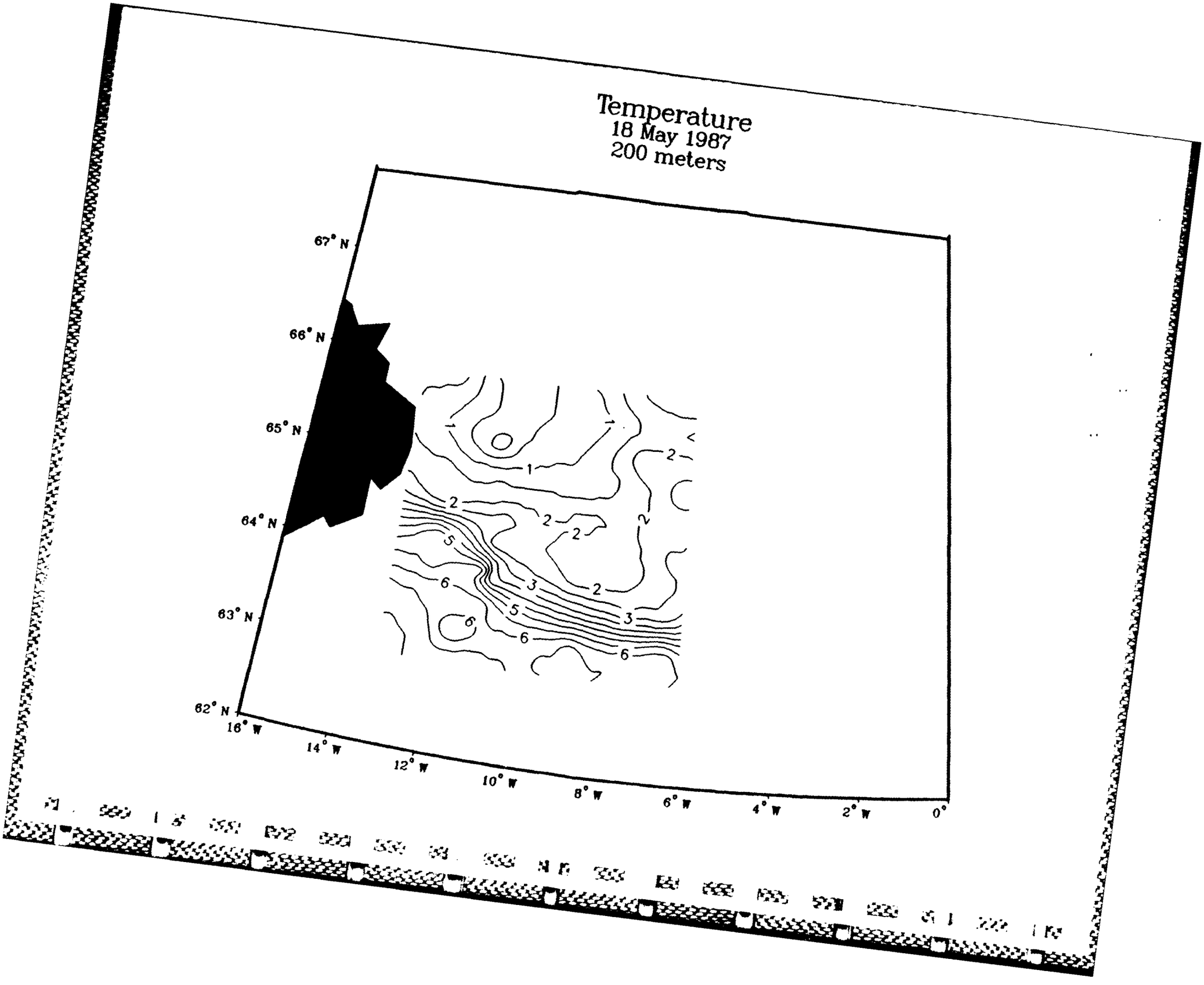
18 May 1987
400 meters

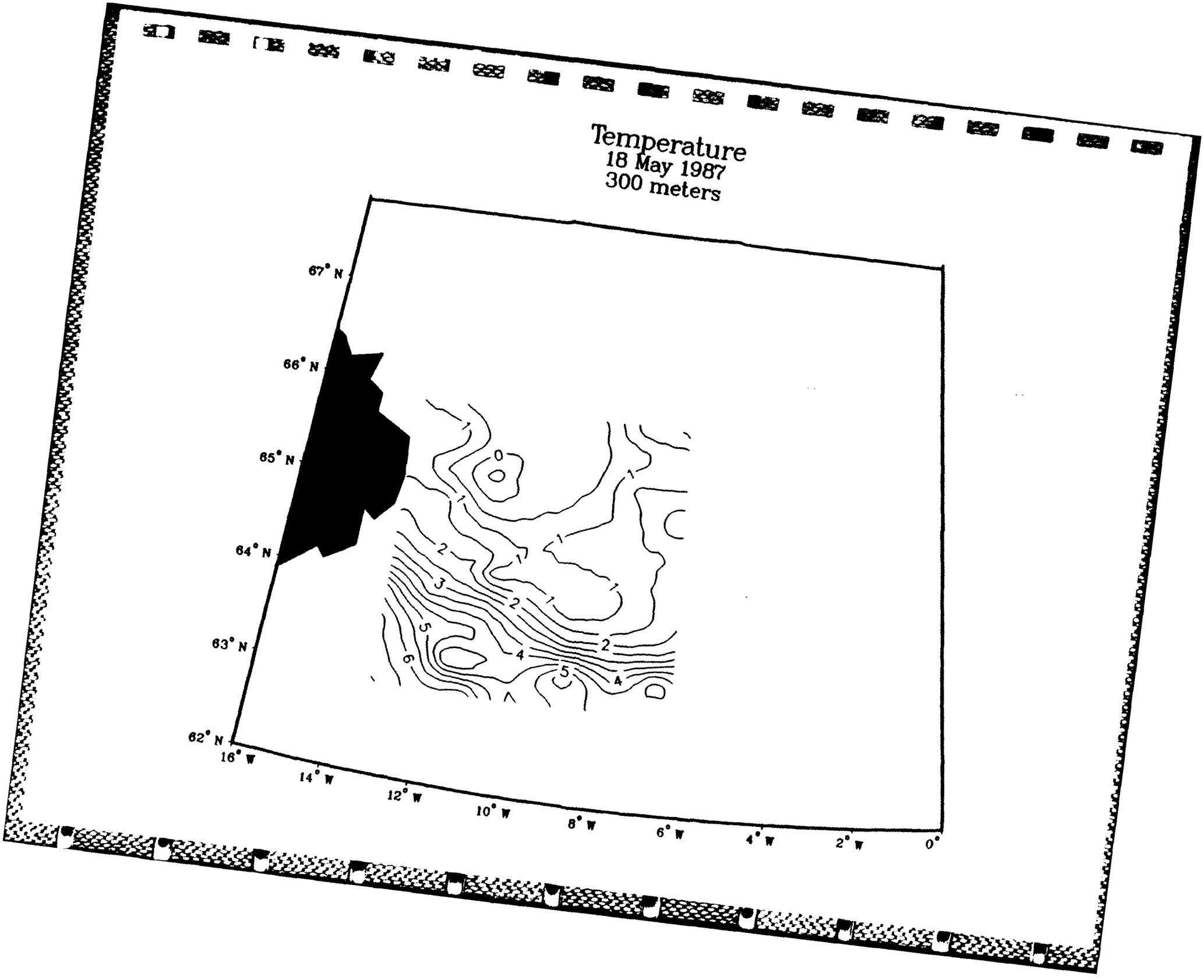



Temperature
18 May 1987
0 meters
67° N
66° N
65° N
64° N
63° N
62° N
16° W
14° W
12° W
10° W
8° W
6° W
4° W
2° W
0°
3
3
3
3
4
5
5
5
6
4
5
7
7
7

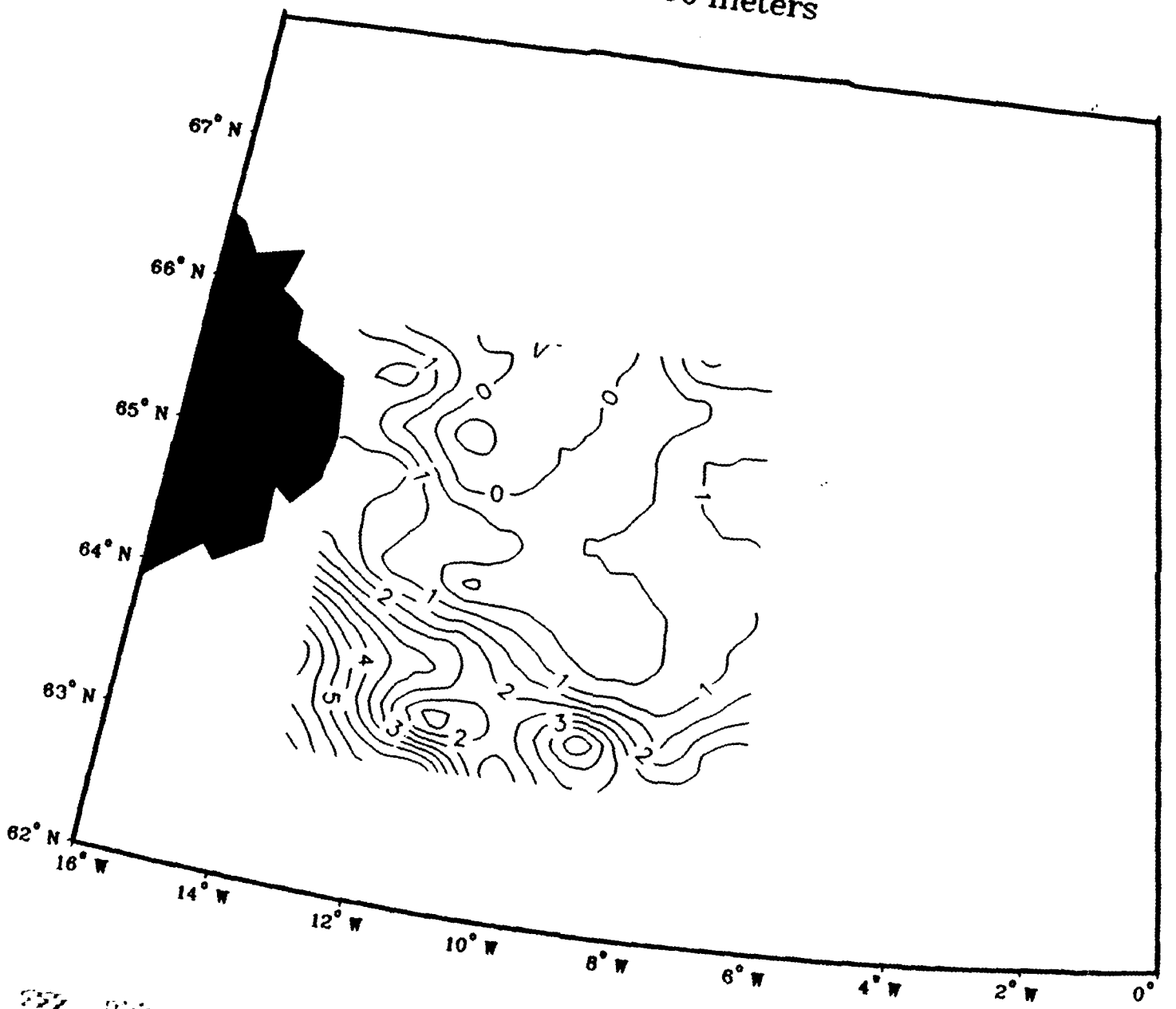
Temperature
18 May 1987
100 meters




Temperature
18 May 1987
200 meters
67° N
66° N
65° N
64° N
63° N
62° N
16° W
14° W
12° W
10° W
8° W
6° W
4° W
2° W
0°
1
2
3
5
6


Temperature
18 May 1987
300 meters
67° N
66° N
65° N
64° N
63° N
62° N
16° W
14° W
12° W
10° W
8° W
6° W
4° W
2° W
0°
0
1
2
3
4
5
6
A
B
C
D

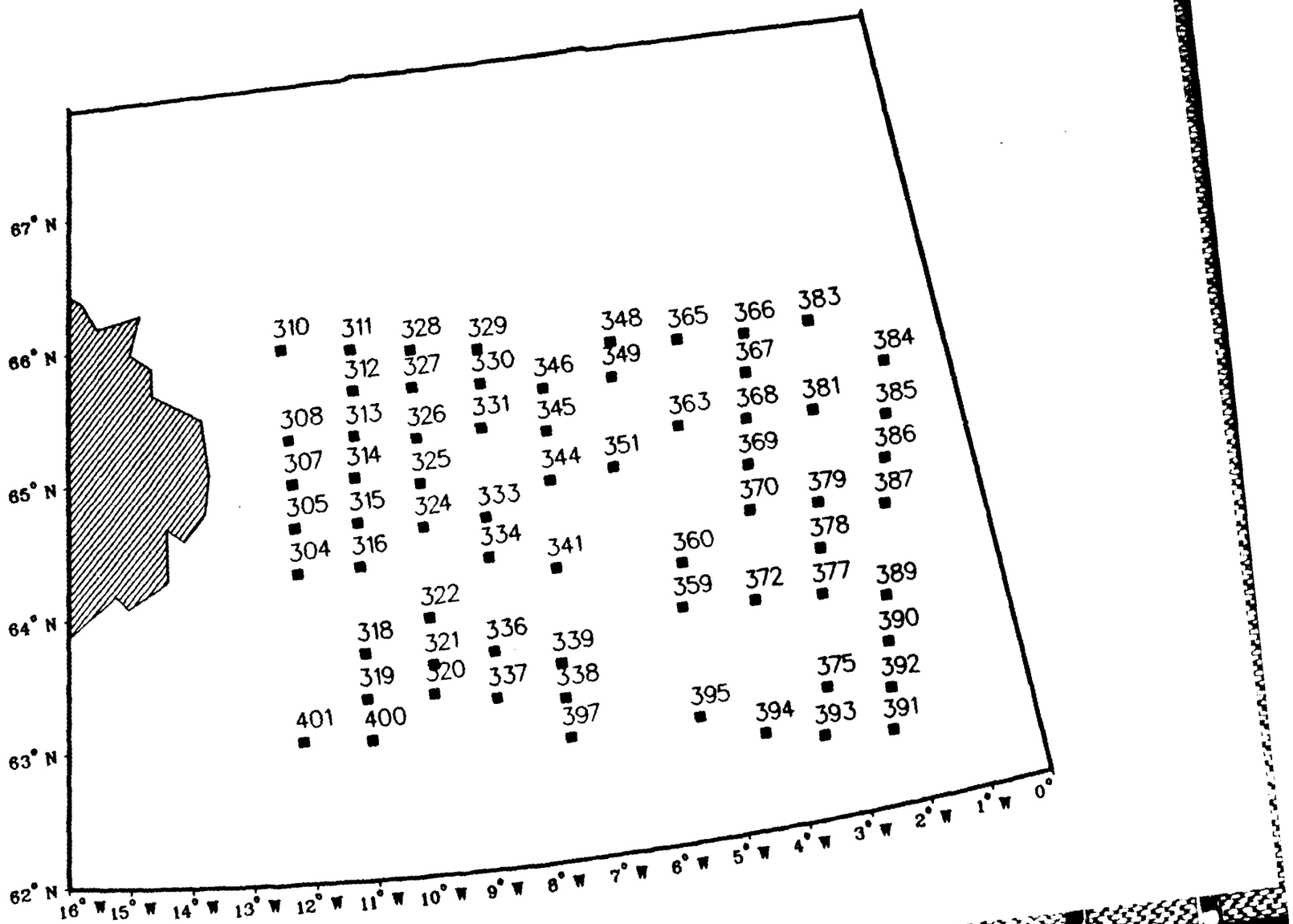
Temperature
18 May 1987
400 meters



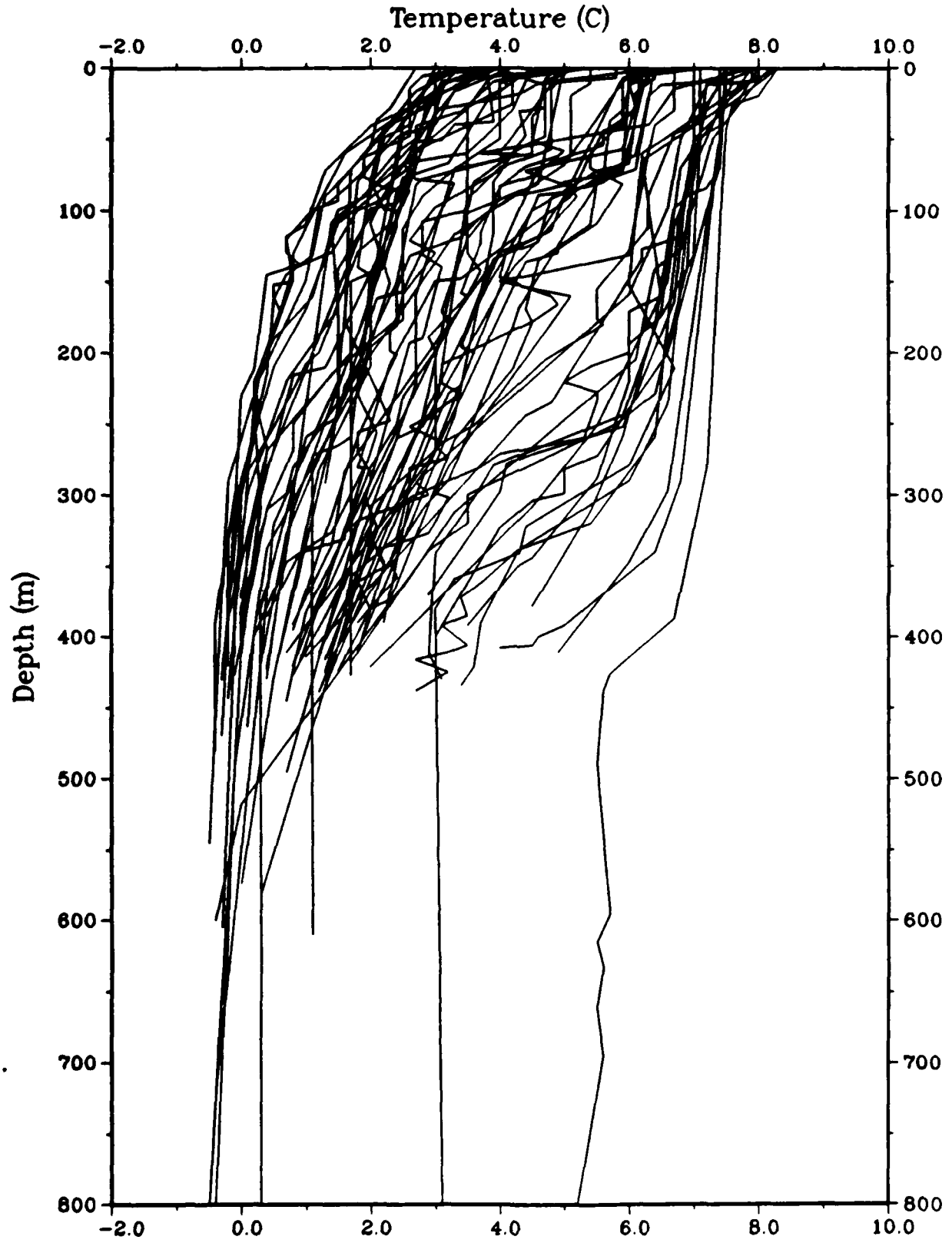
[illegible] Frontal Zone
Survey #3

22 May 1987

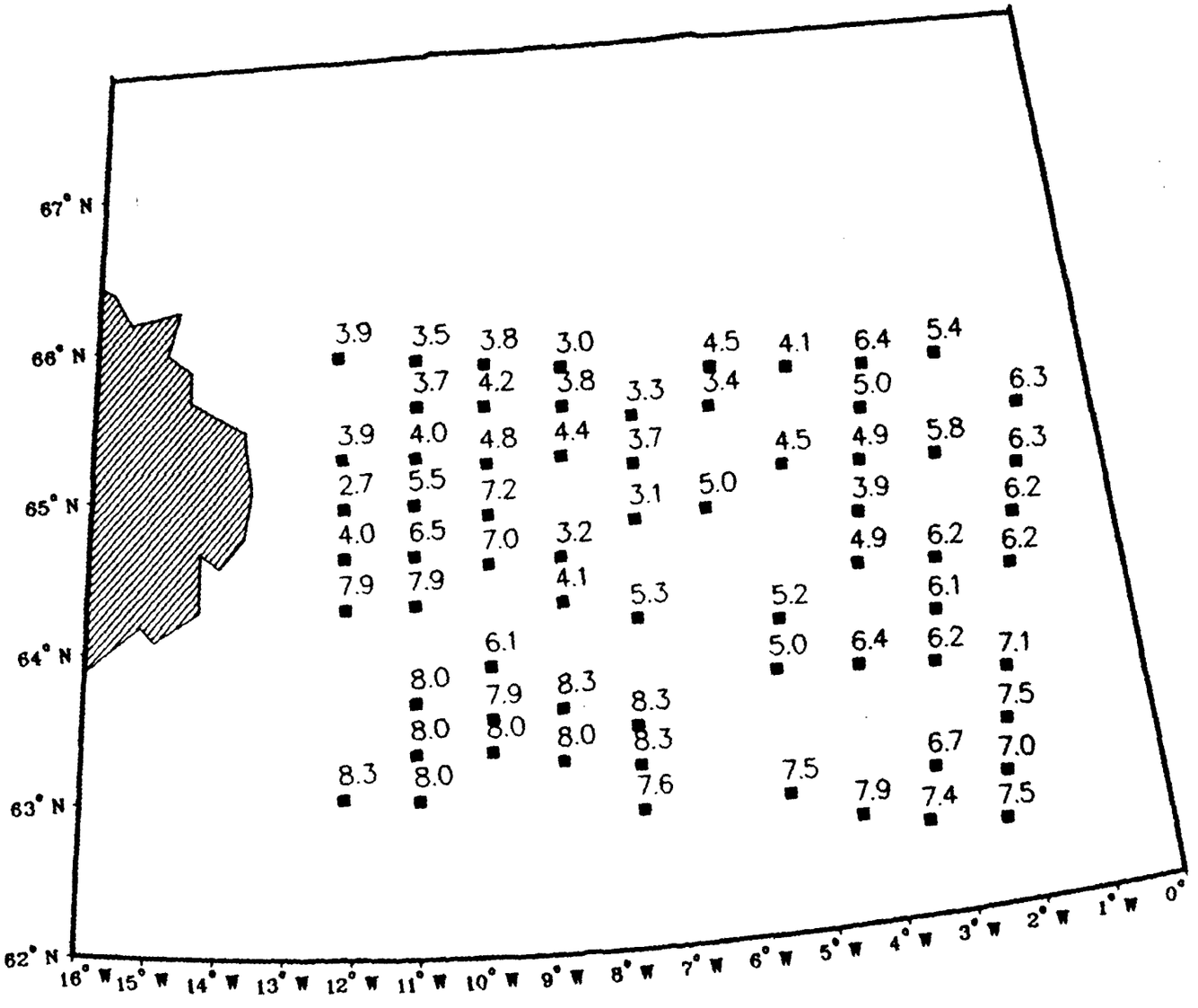
22 May 1987
AXBT Stations

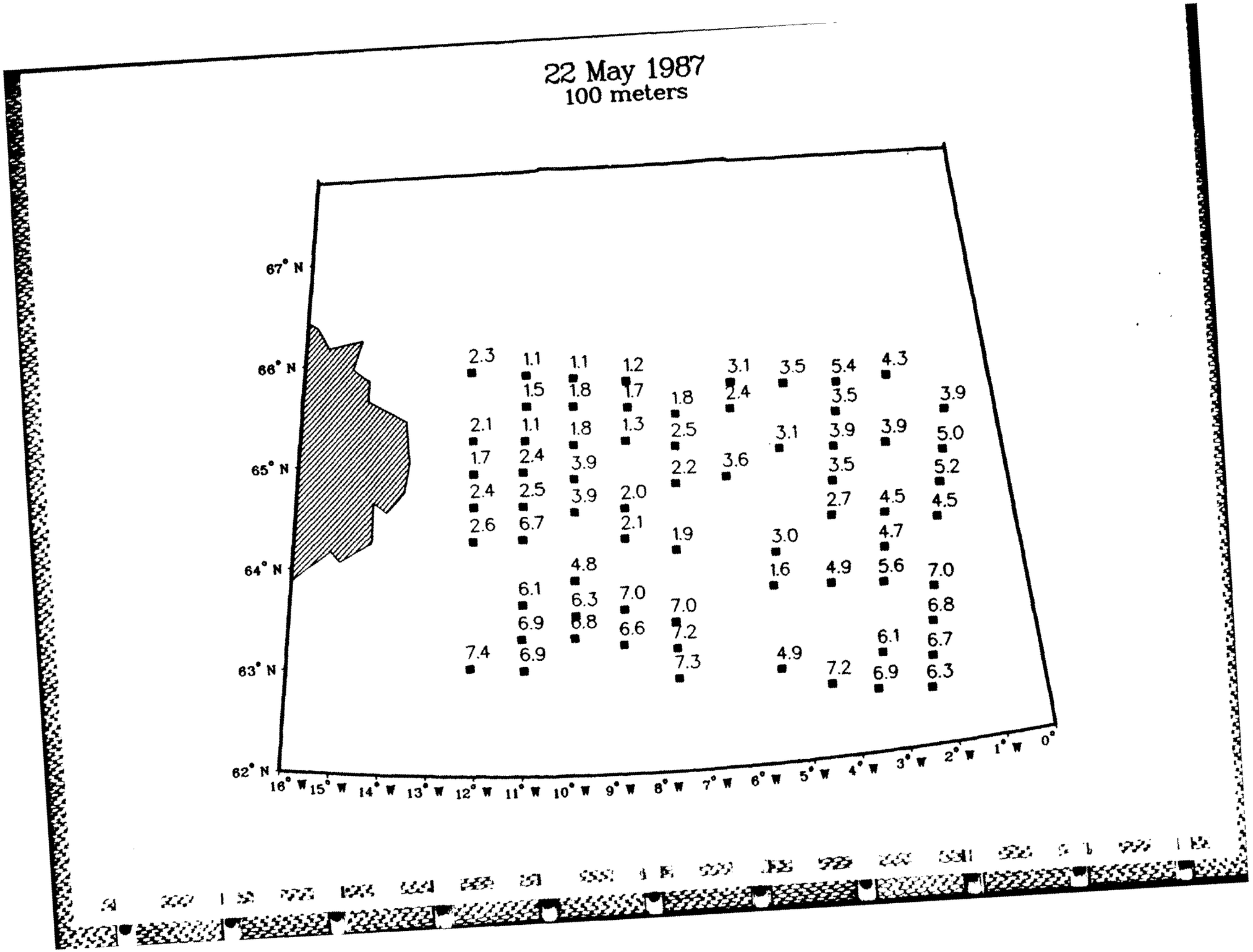


22 May 1987

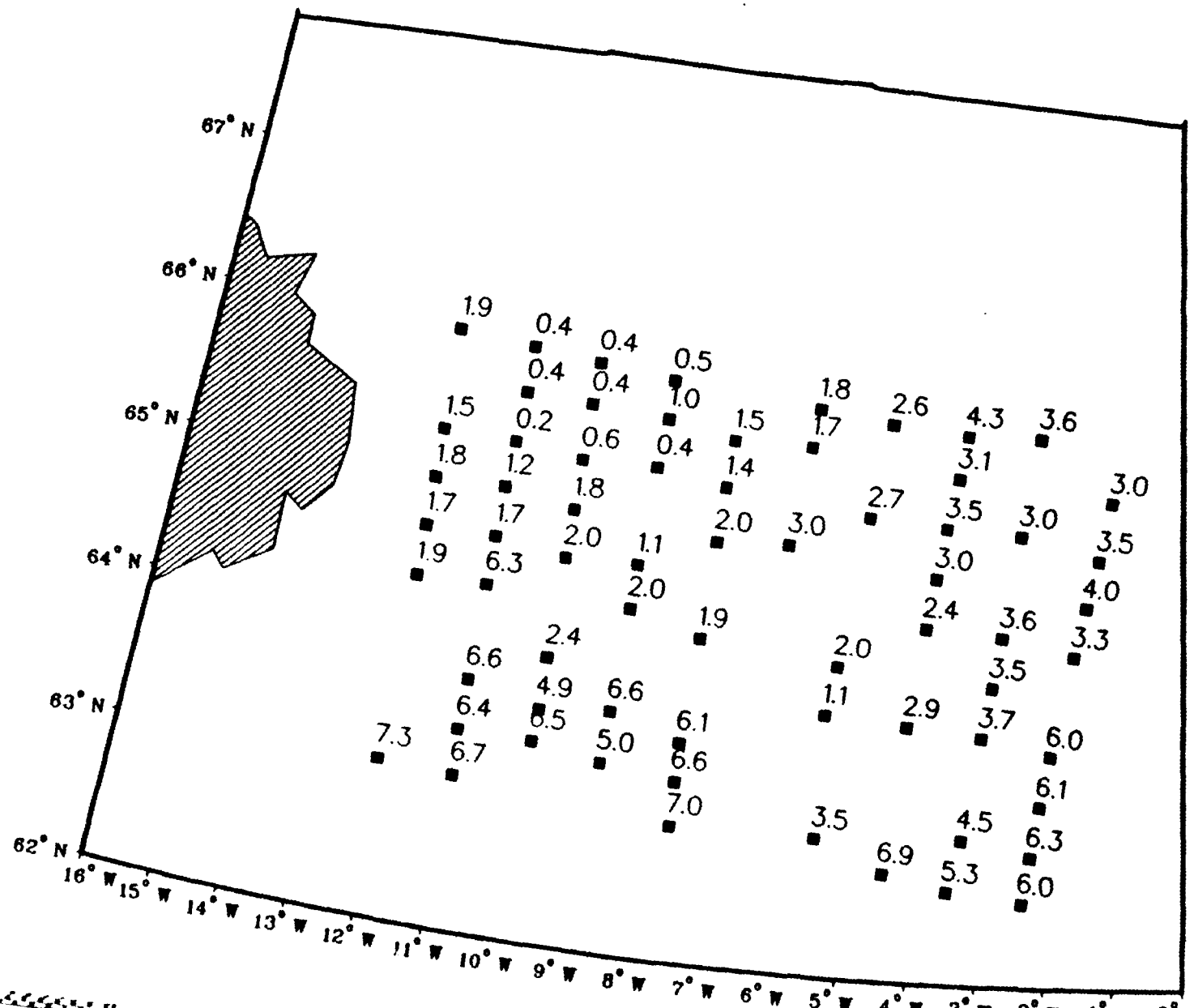

Temperature (C)
-2.0
0.0
2.0
4.0
6.0
8.0
10.0
Depth (m)
0
100
200
300
400
500
600
700
800

22 May 1987
0 meters

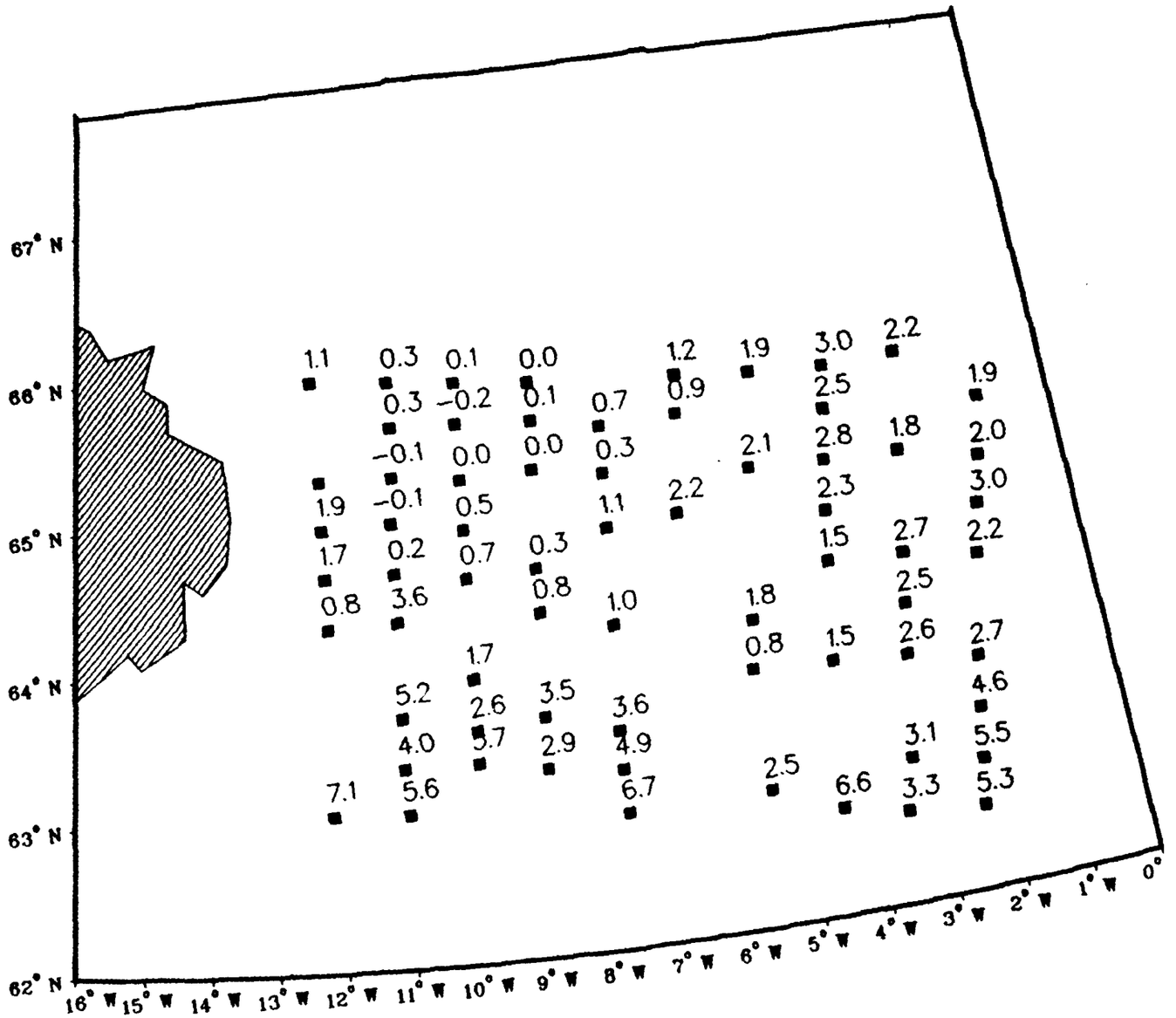



22 May 1987
100 meters
67° N
66° N
65° N
64° N
63° N
62° N
16° W
15° W
14° W
13° W
12° W
11° W
10° W
9° W
8° W
7° W
6° W
5° W
4° W
3° W
2° W
1° W
0°
2.3
1.1
1.1
1.2
1.8
3.1
3.5
5.4
4.3
1.5
1.8
1.7
2.4
3.5
3.9
2.1
1.1
1.8
1.3
2.5
3.1
3.9
3.9
5.0
1.7
2.4
3.9
2.2
3.6
3.5
5.2
2.4
2.5
3.9
2.0
2.7
4.5
4.5
2.6
6.7
2.1
1.9
3.0
4.7
4.8
1.6
4.9
5.6
7.0
6.1
6.3
7.0
7.0
6.8
6.9
6.8
6.6
7.2
6.1
6.7
7.4
6.9
7.3
4.9
7.2
6.9
6.3

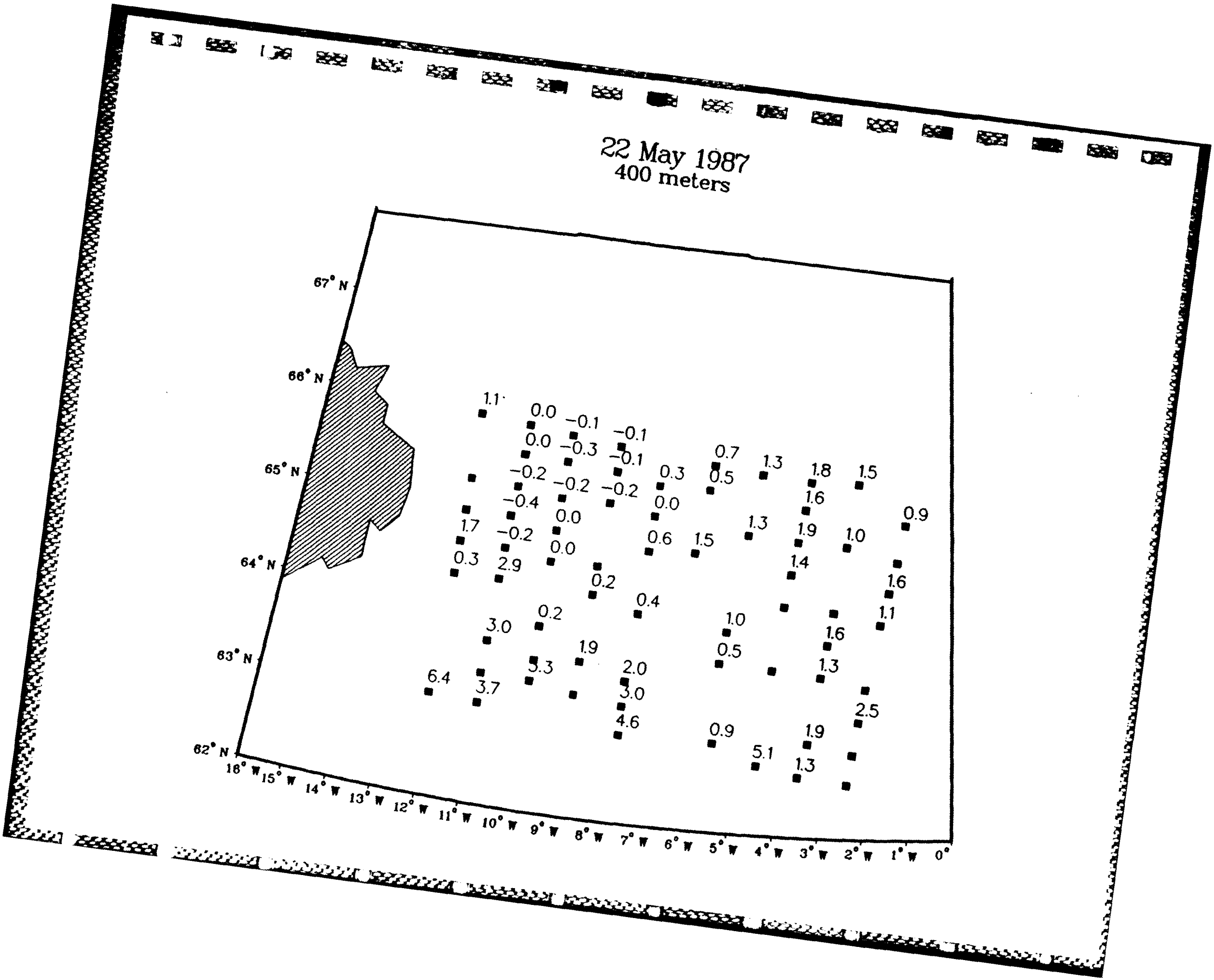
22 May 1987
200 meters



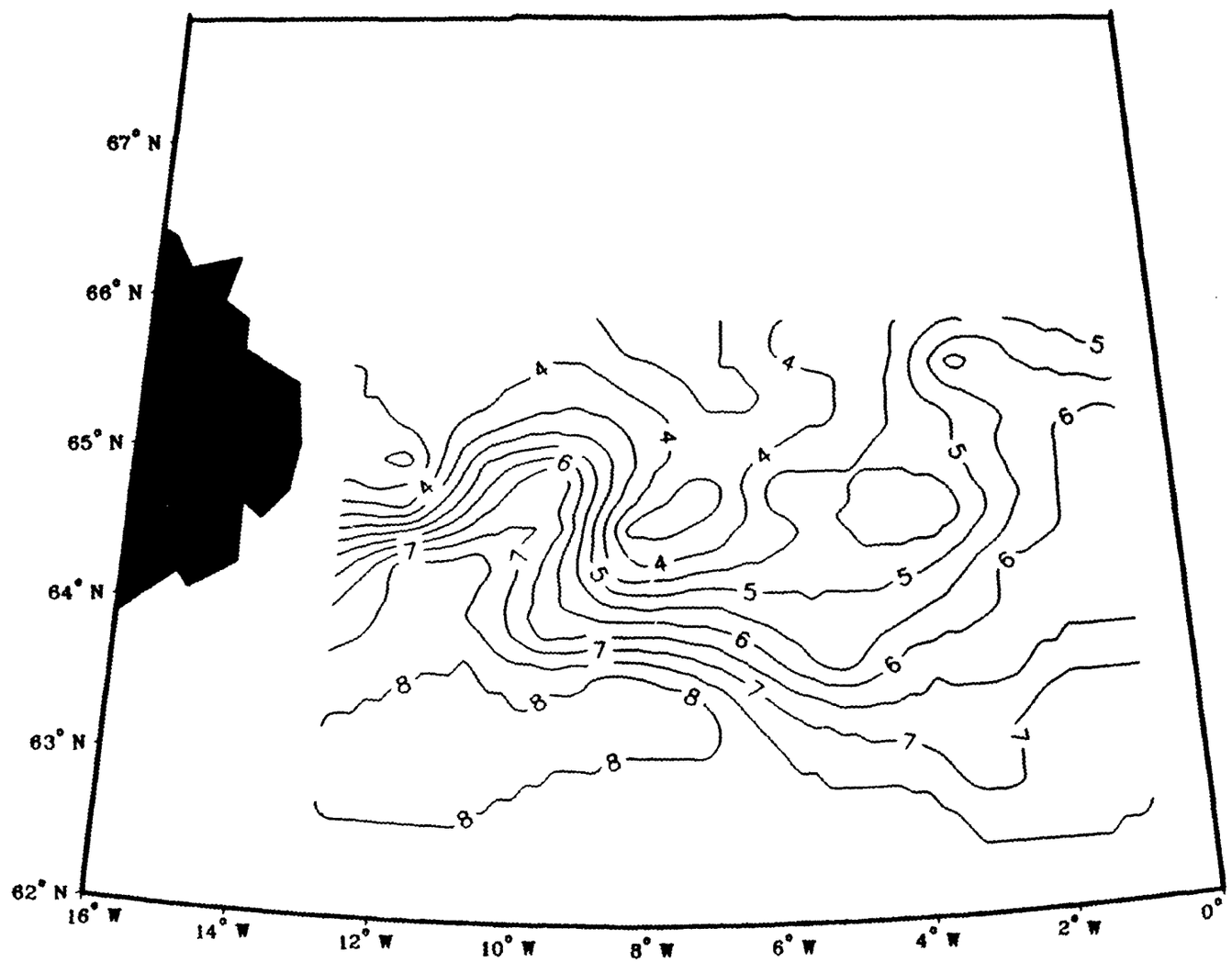
22 May 1987
300 meters

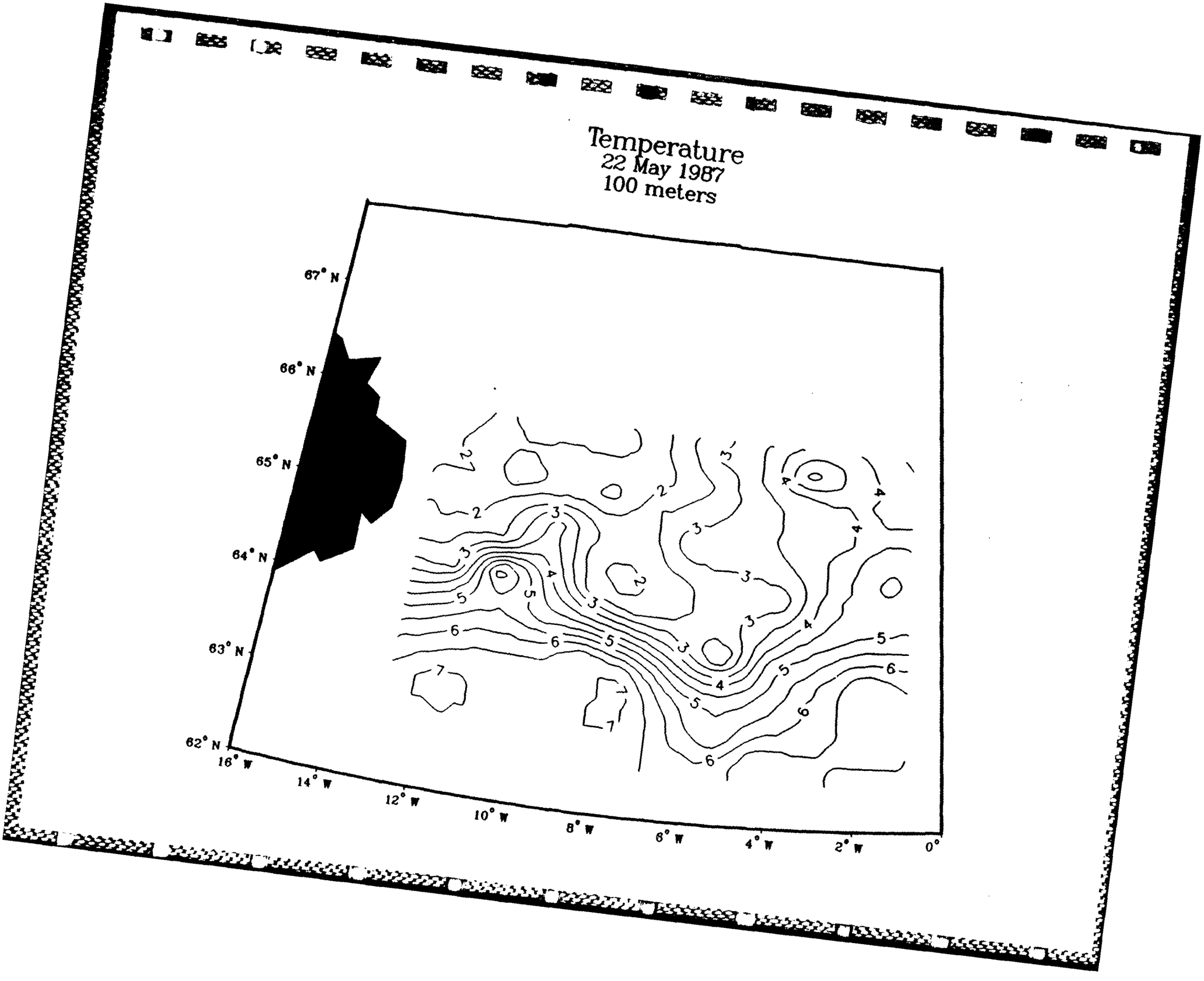


22 May 1987
400 meters

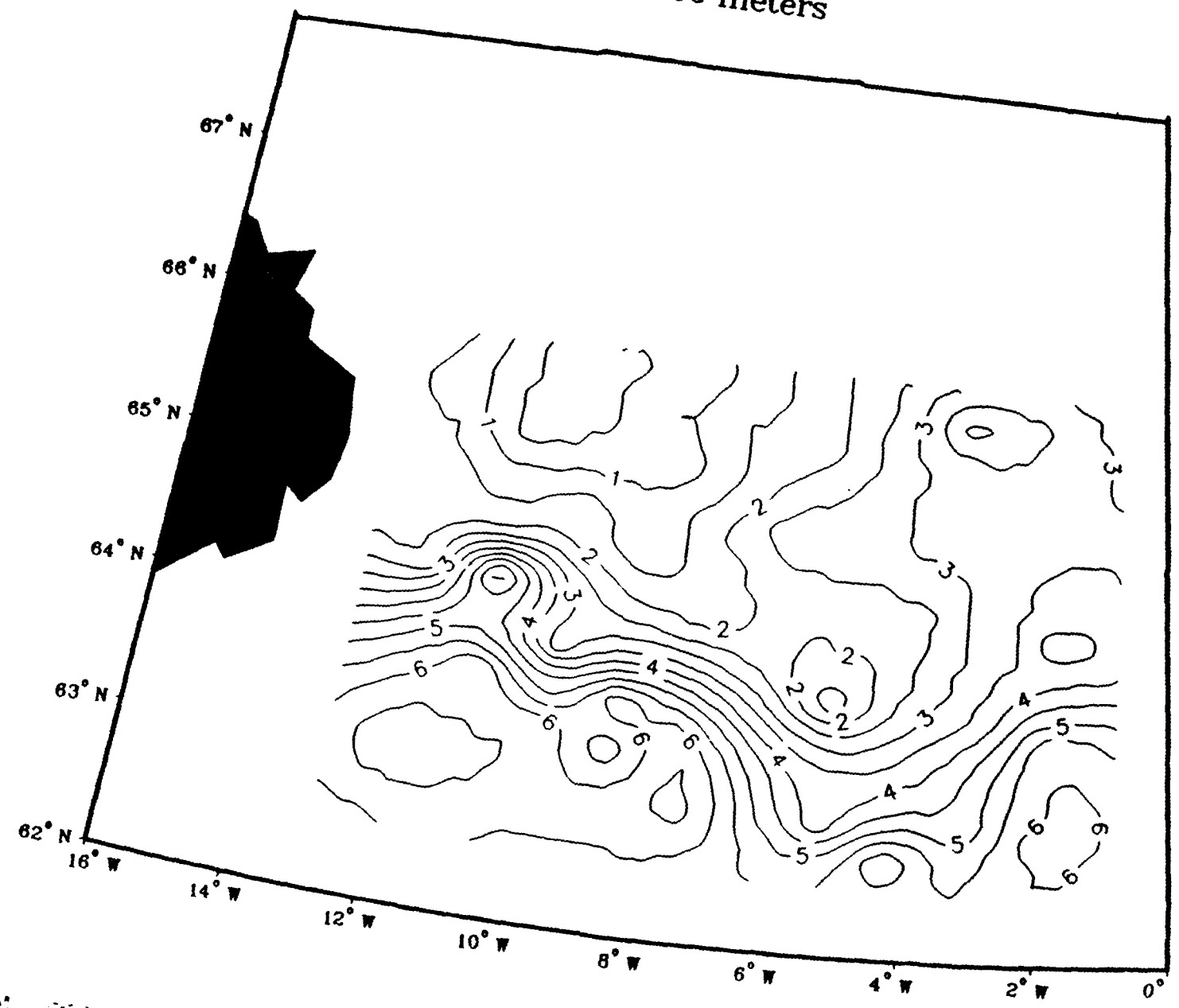


Temperature
22 May 1987
0 meters

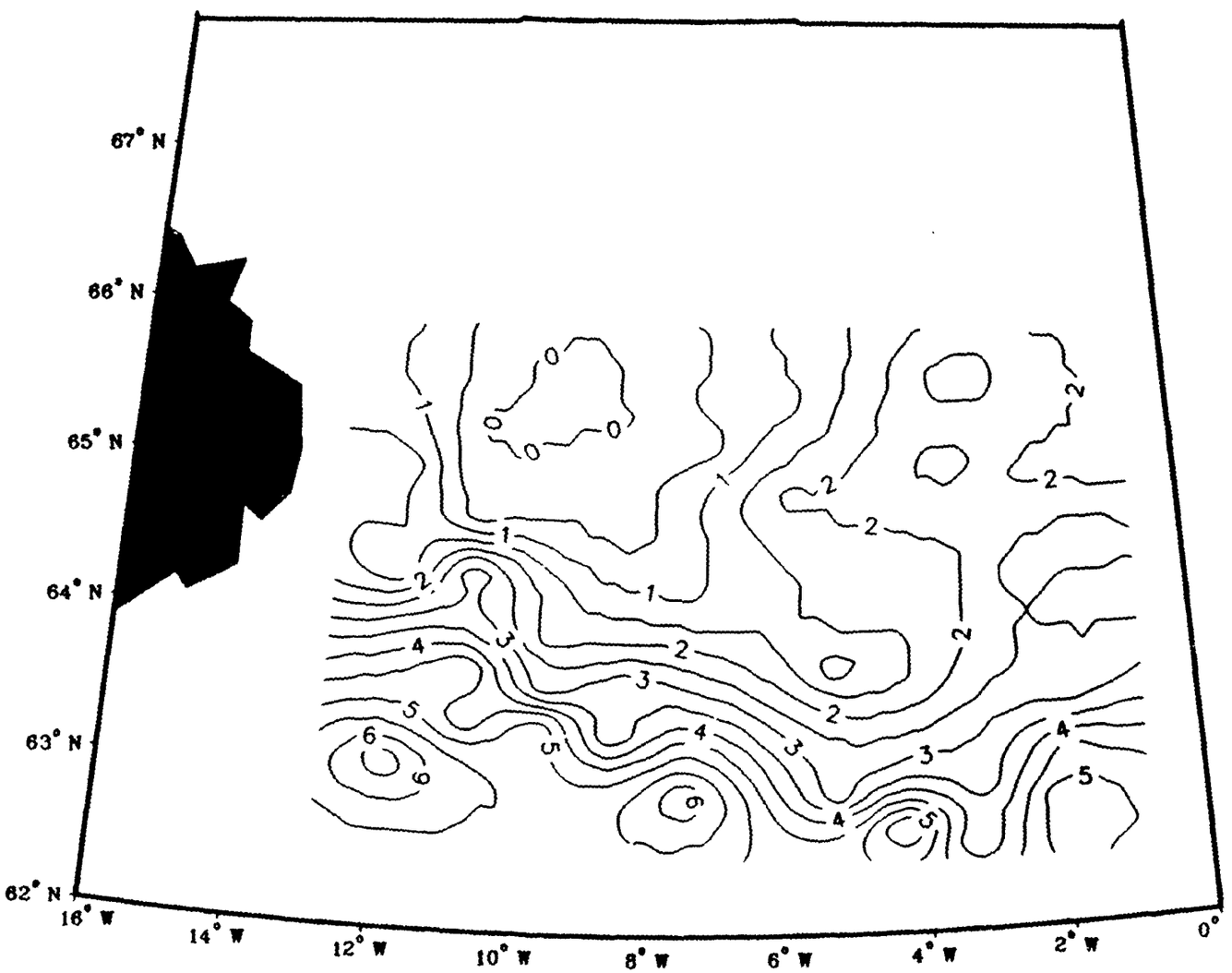


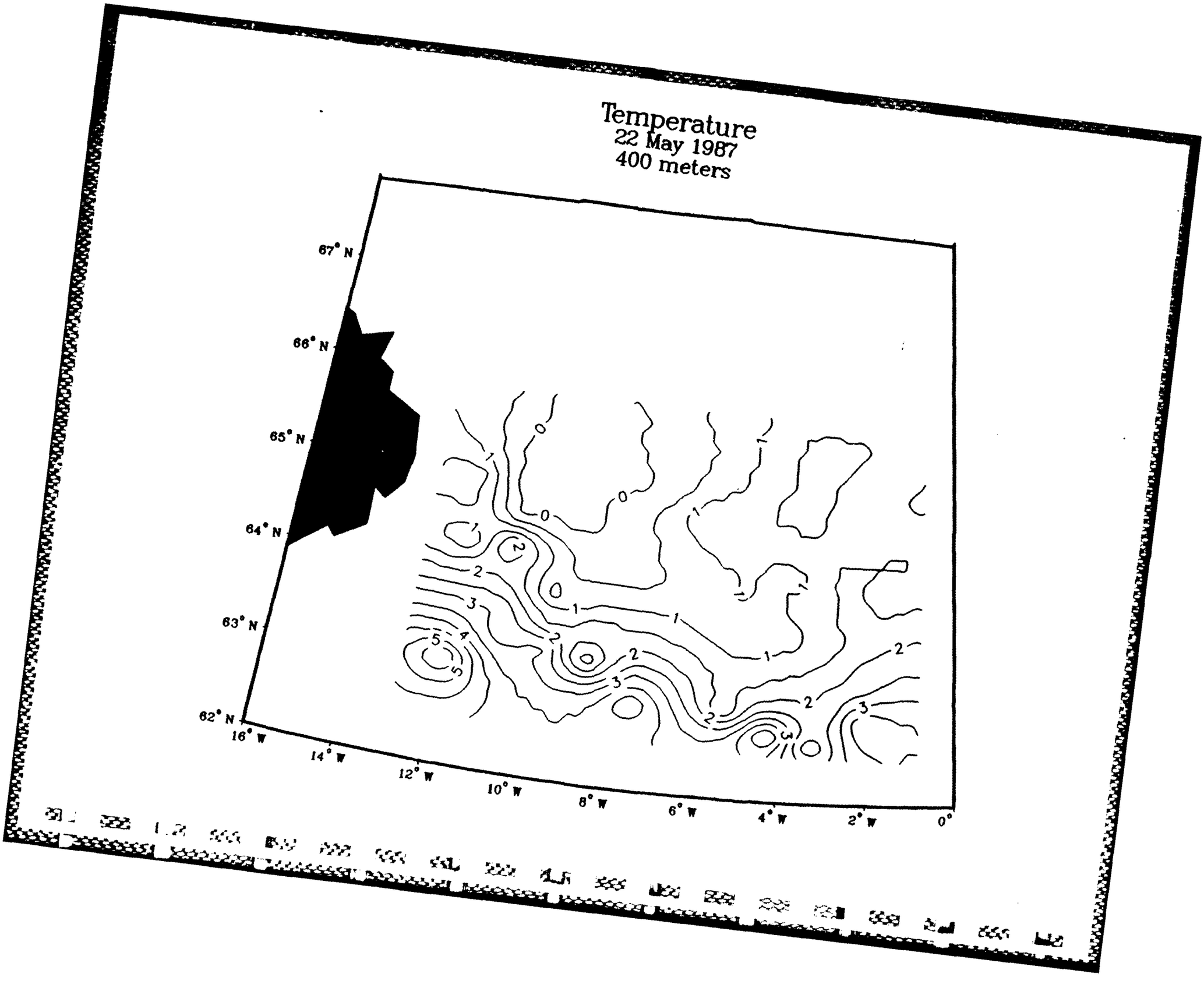

Temperature
22 May 1987
100 meters
67° N
66° N
65° N
64° N
63° N
62° N
18° W
14° W
12° W
10° W
8° W
6° W
4° W
2° W
0°

Temperature
22 May 1987
200 meters



Temperature
22 May 1987
300 meters

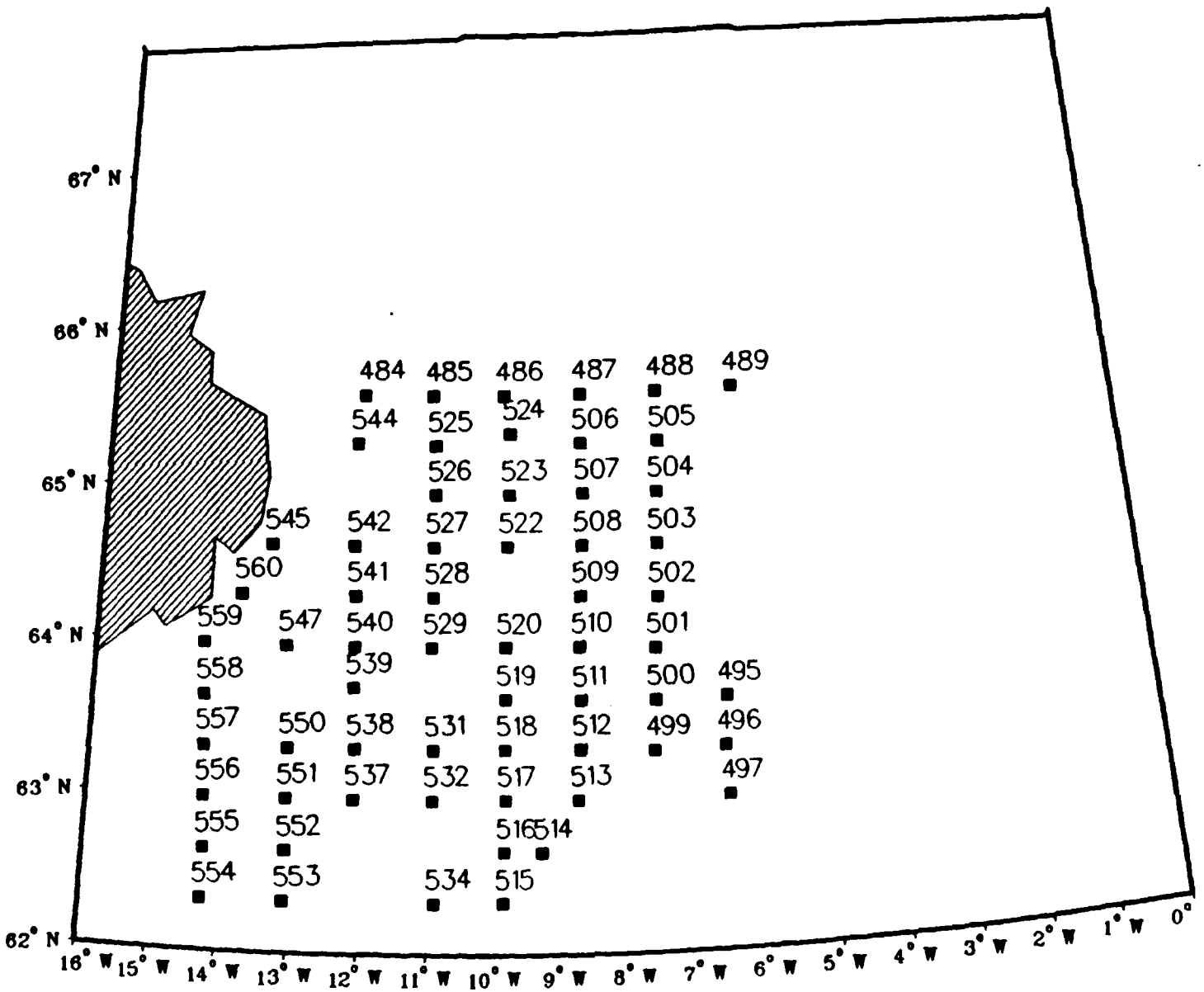



Temperature
22 May 1987
400 meters
67° N
66° N
65° N
64° N
63° N
62° N
16° W
14° W
12° W
10° W
8° W
6° W
4° W
2° W
0°

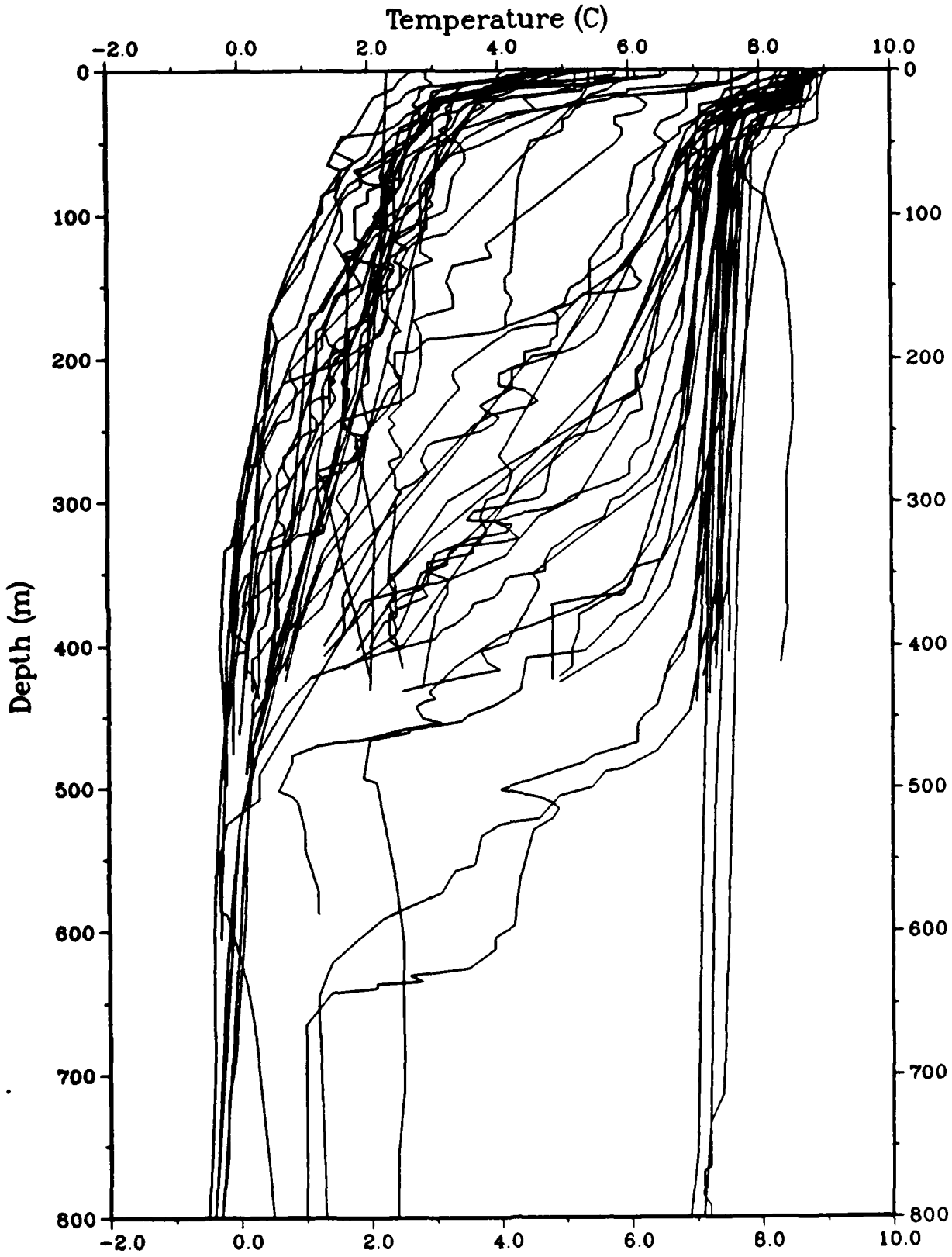
Iceland-Faeroe Frontal Zone
Survey #4

26 May 1987

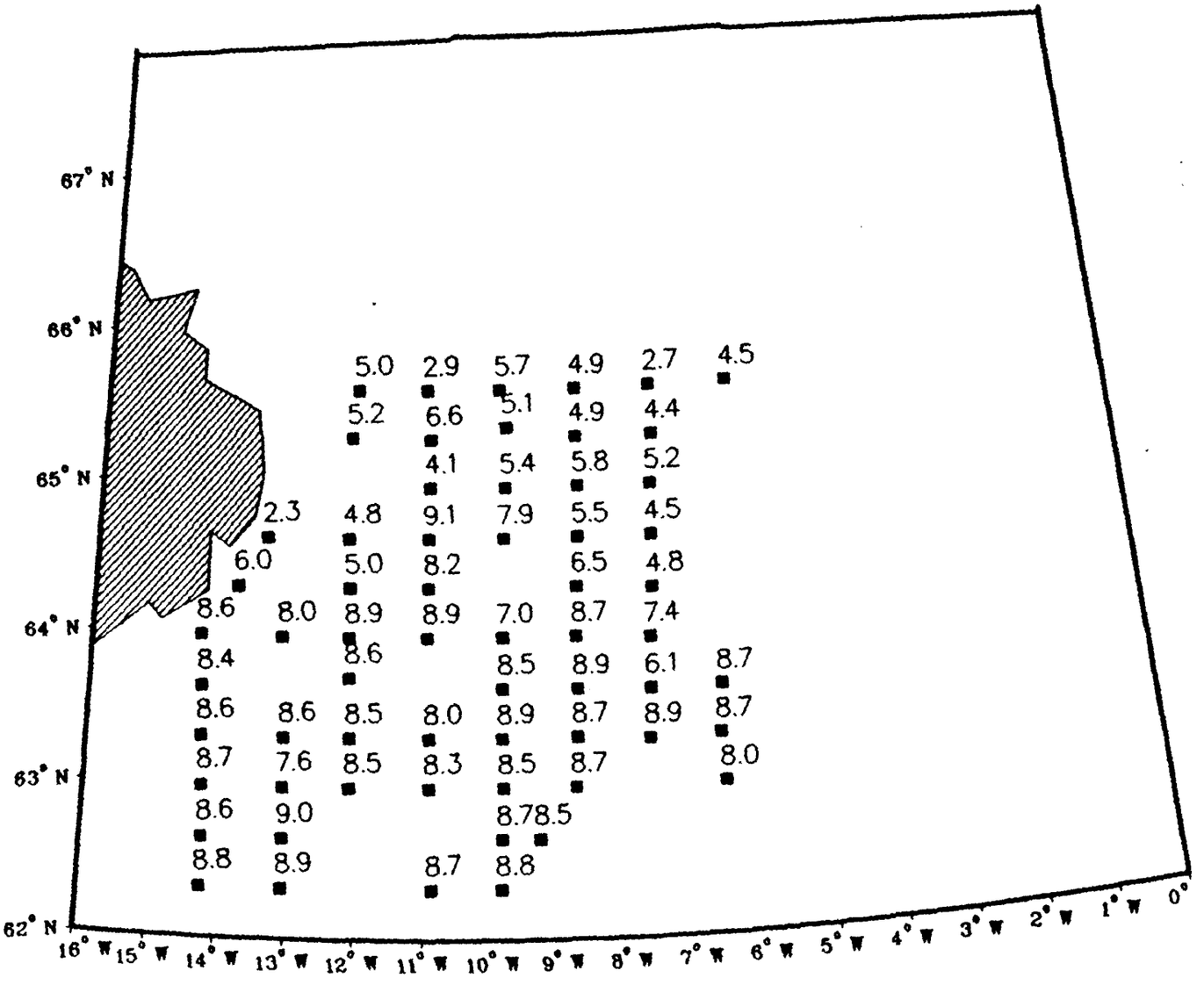
26 May 1987
AXBT Stations



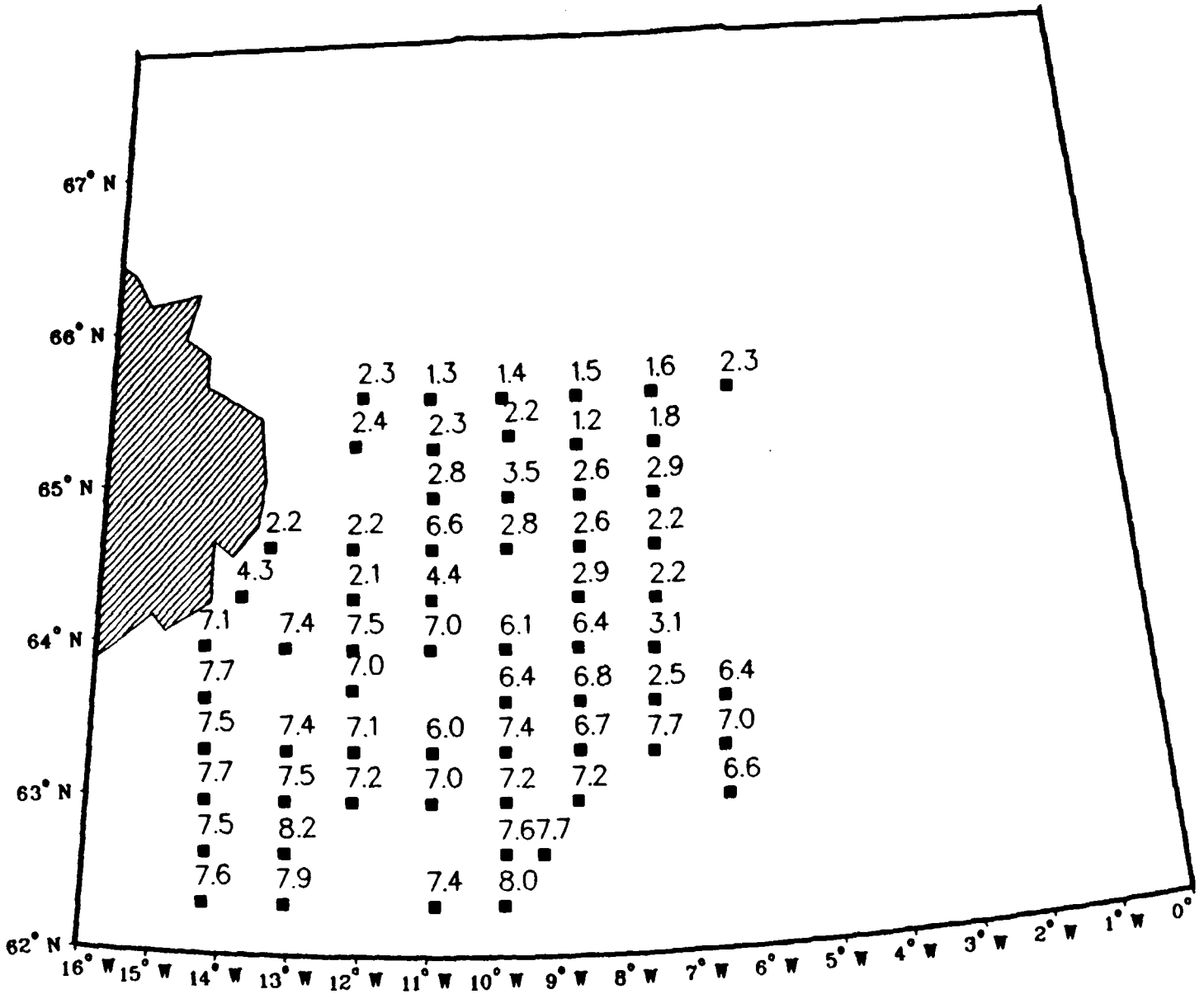
26 May 1987


Temperature (C)
-2.0
0.0
2.0
4.0
6.0
8.0
10.0
Depth (m)
0
100
200
300
400
500
600
700
800

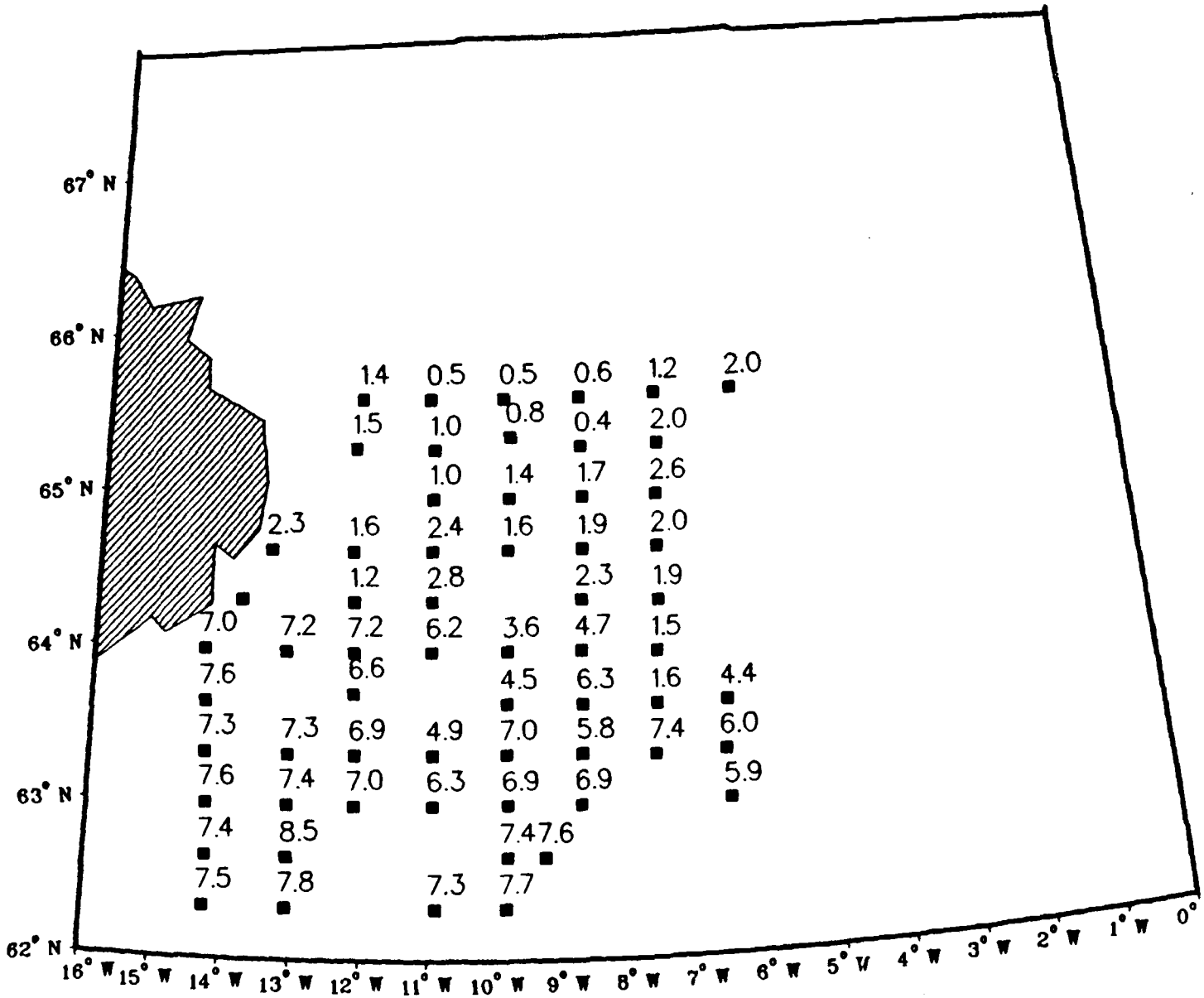
26 May 1987
0 meters



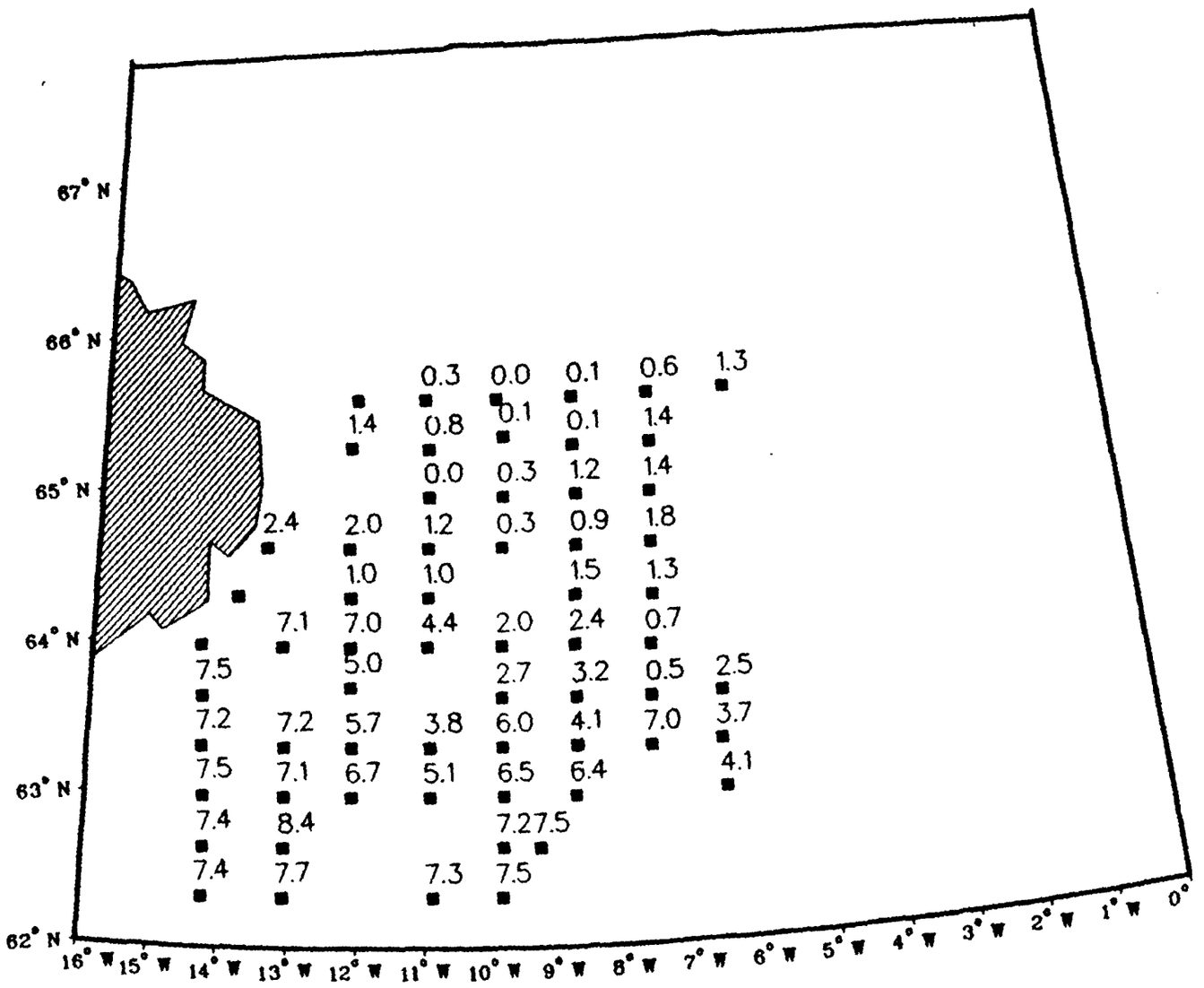
26 May 1987
100 meters



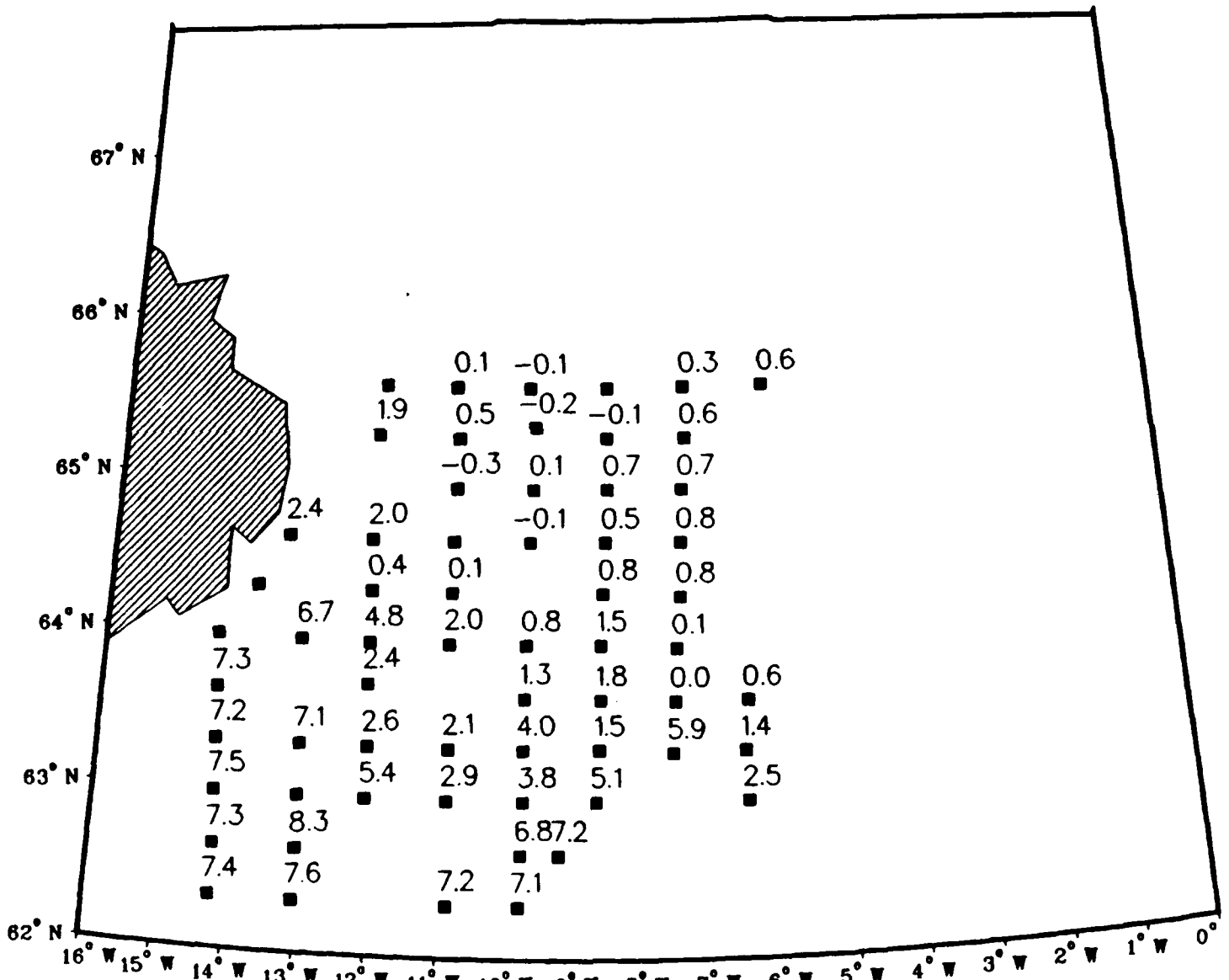
26 May 1987
200 meters



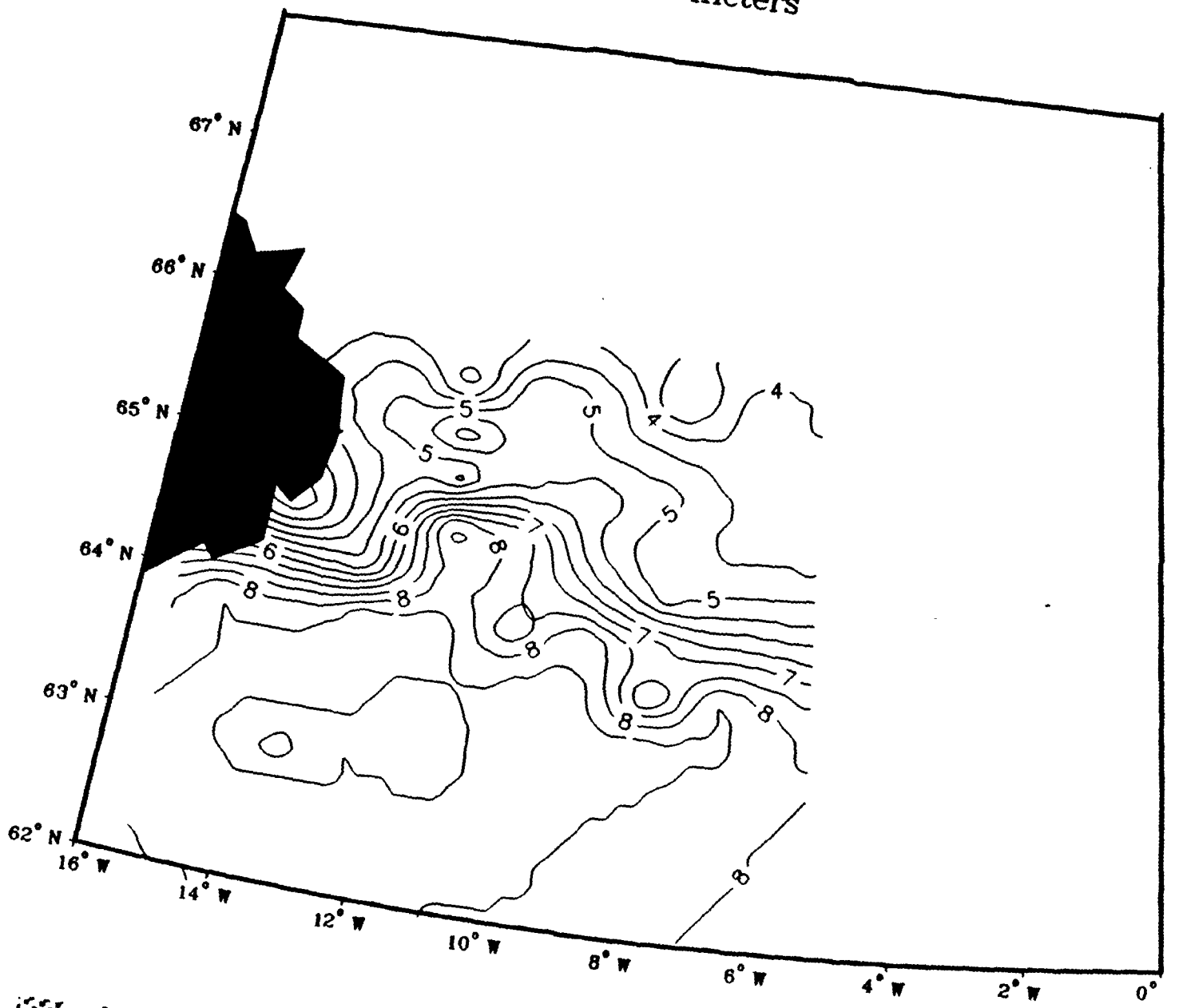
26 May 1987
300 meters

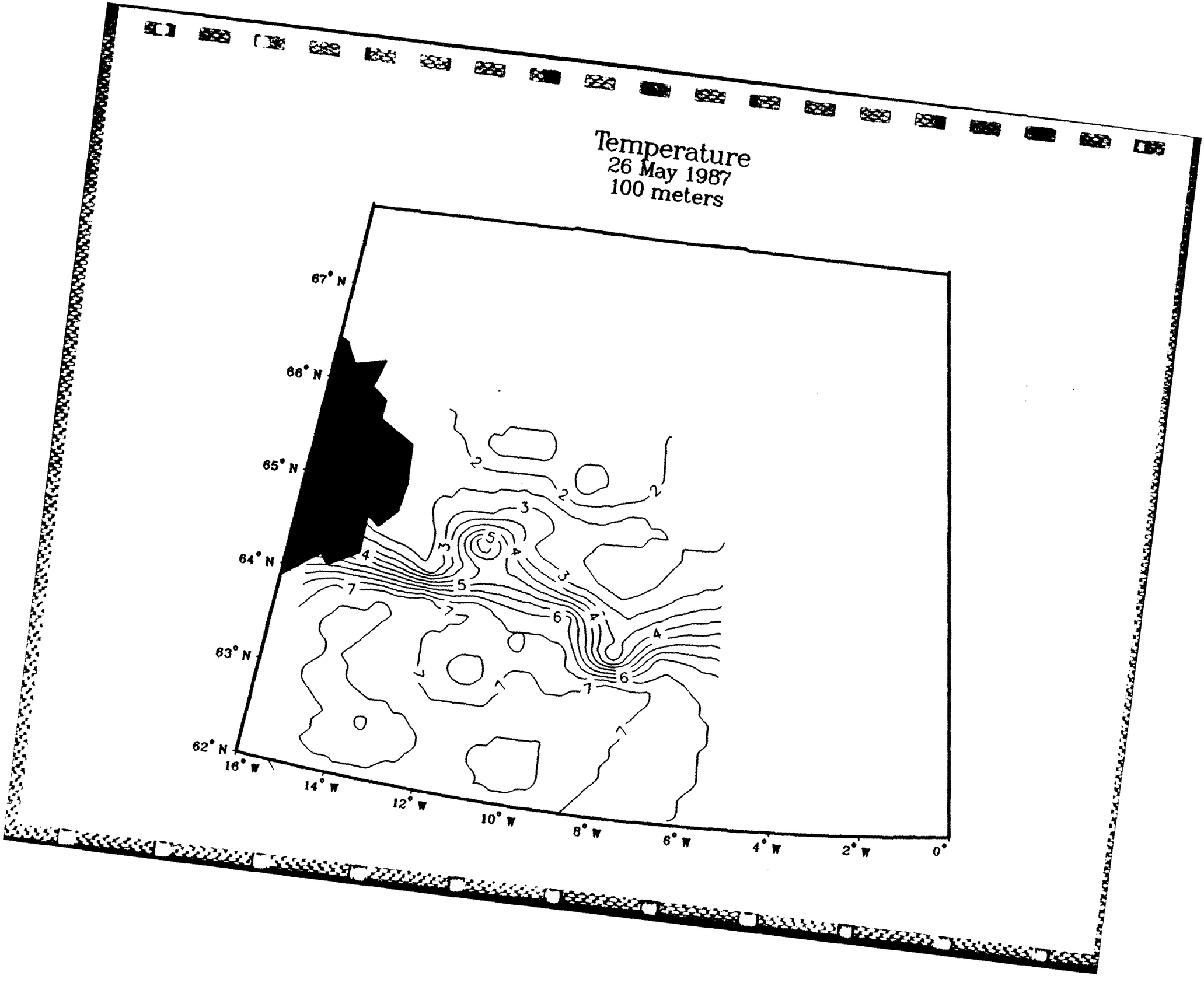


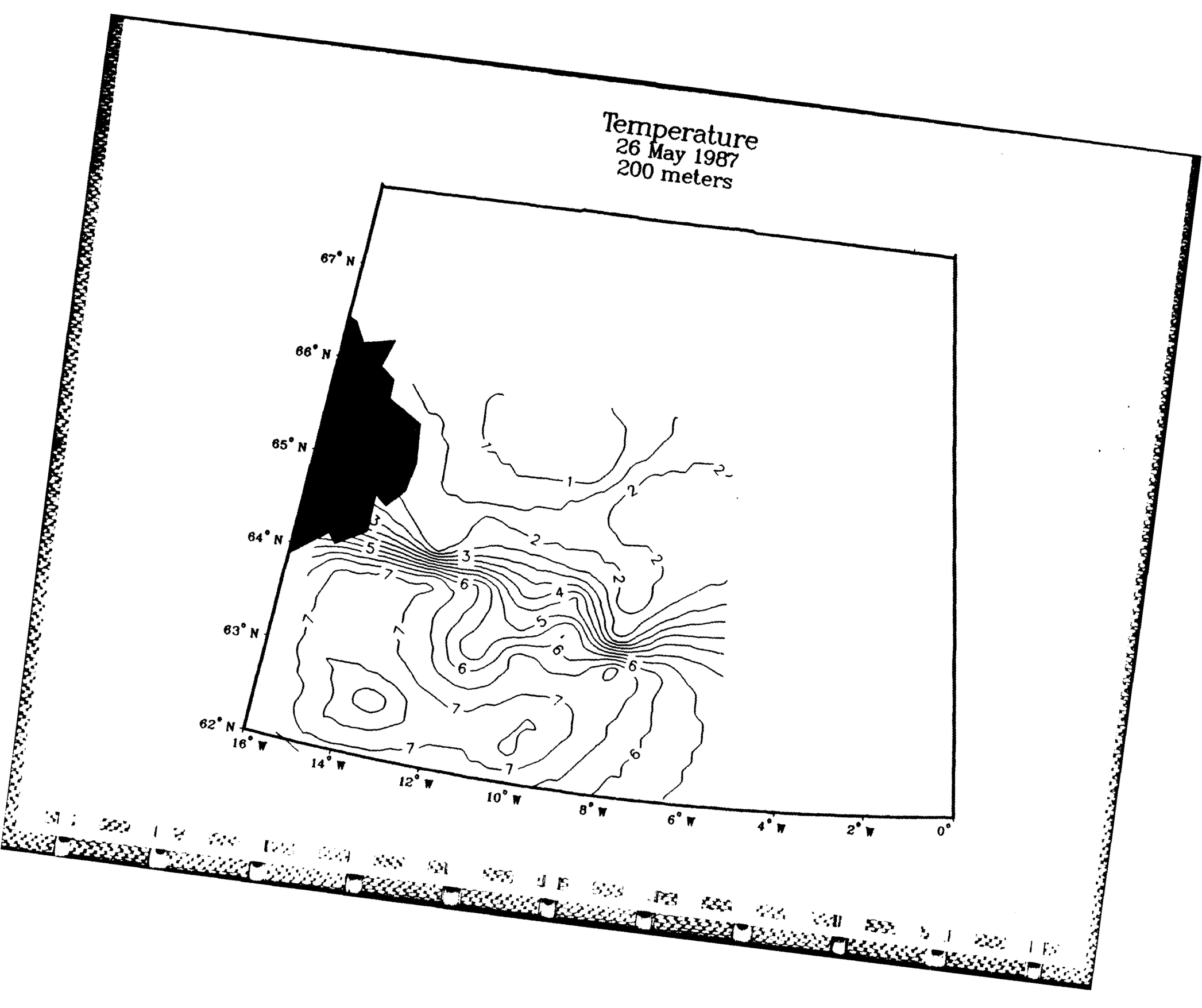
26 May 1987
400 meters

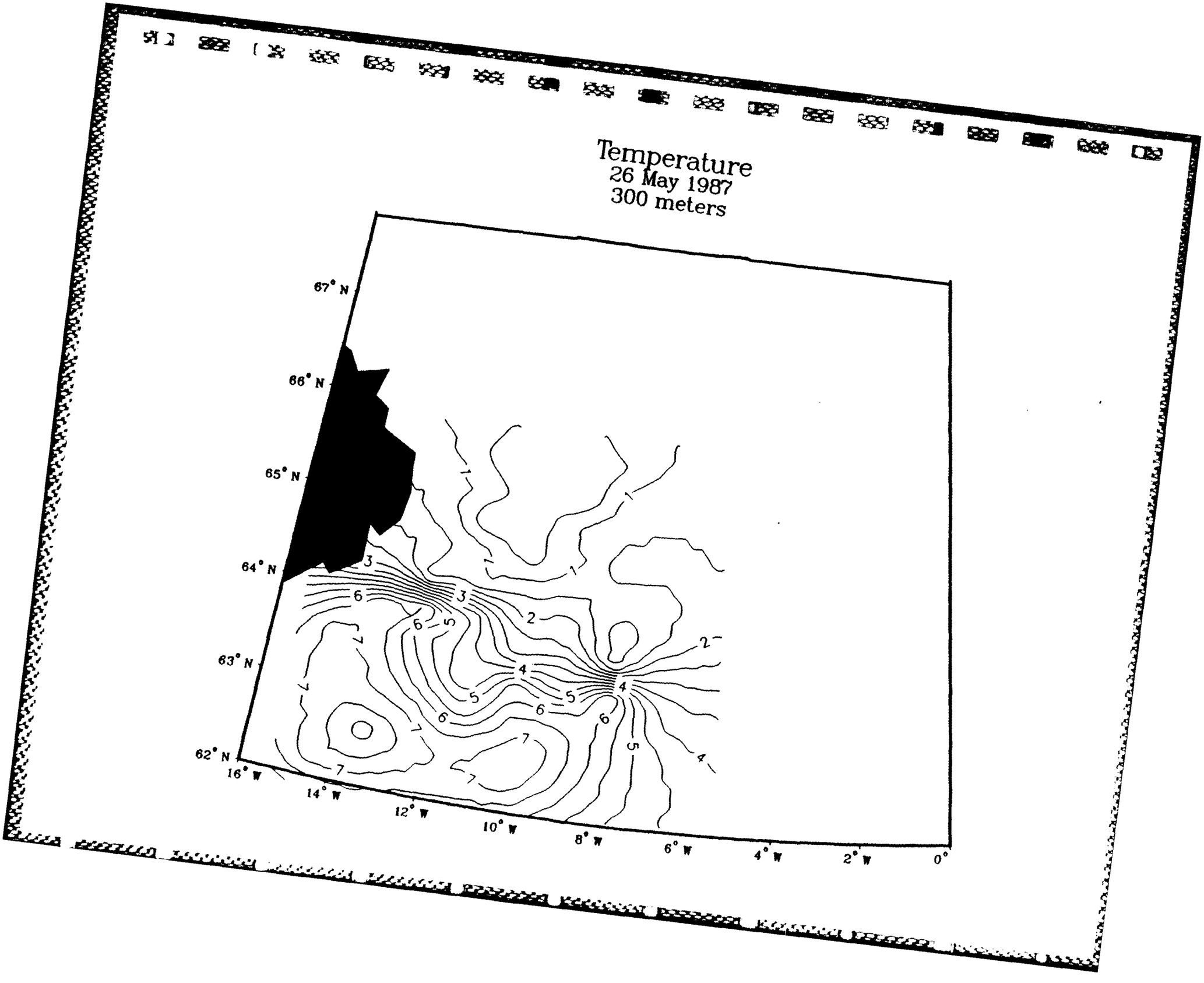


Temperature
26 May 1987
0 meters

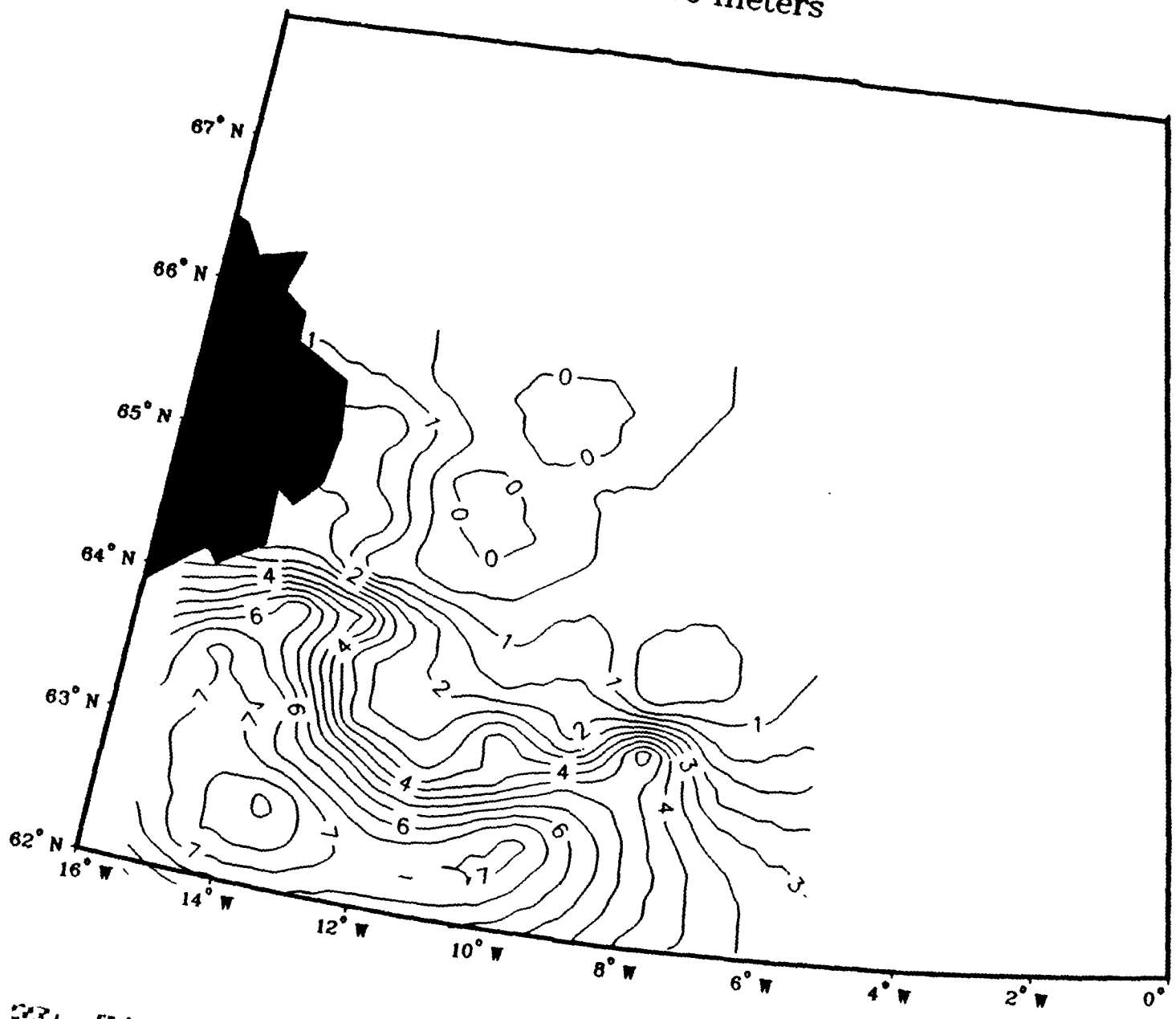



Temperature
26 May 1987
100 meters
67° N
66° N
65° N
64° N
63° N
62° N
16° W
14° W
12° W
10° W
8° W
6° W
4° W
2° W
0°


Temperature
26 May 1987
200 meters
67° N
66° N
65° N
64° N
63° N
62° N
16° W
14° W
12° W
10° W
8° W
6° W
4° W
2° W
0°


Temperature
26 May 1987
300 meters
67° N
66° N
65° N
64° N
63° N
62° N
16° W
14° W
12° W
10° W
8° W
6° W
4° W
2° W
0°

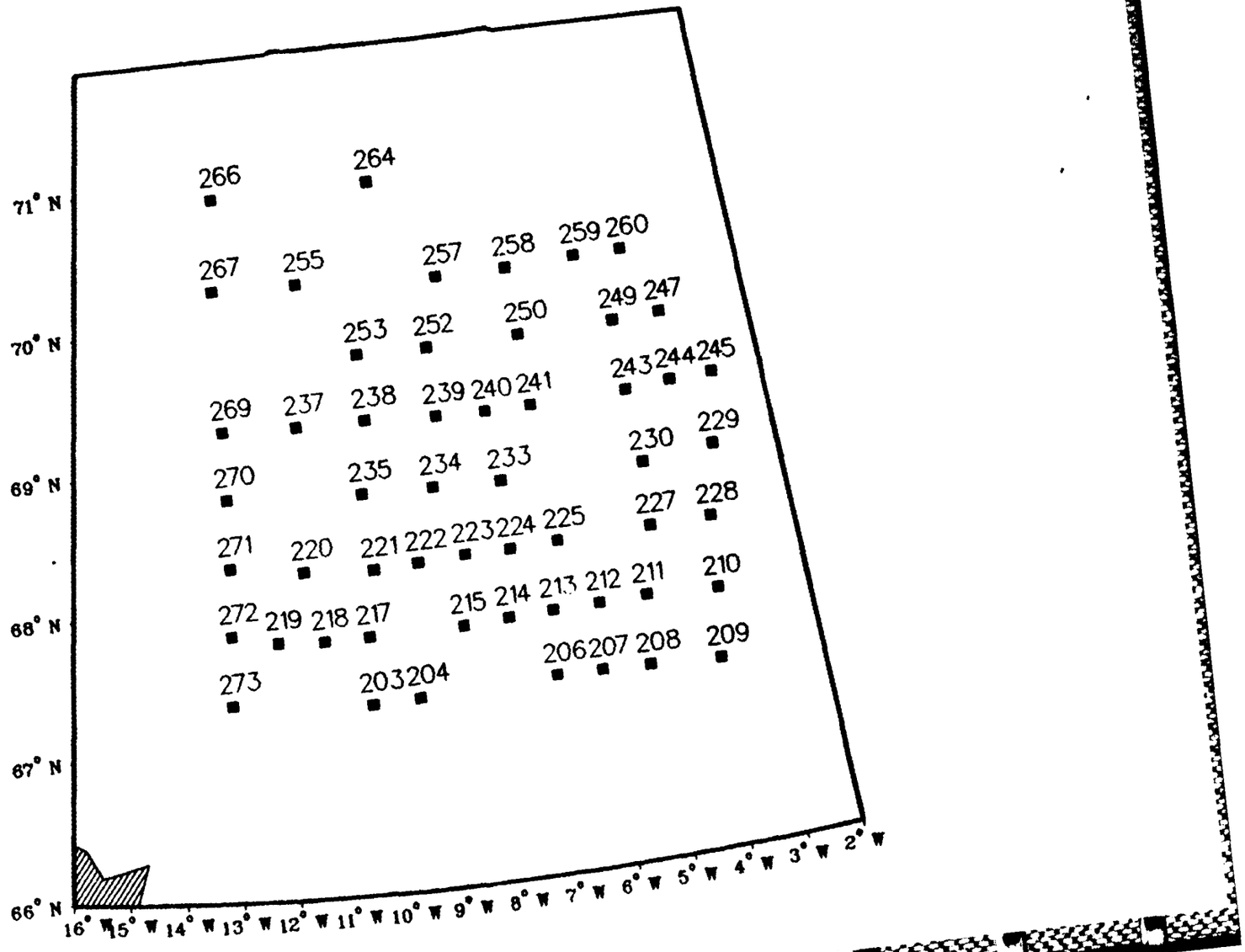
Temperature
26 May 1987
400 meters



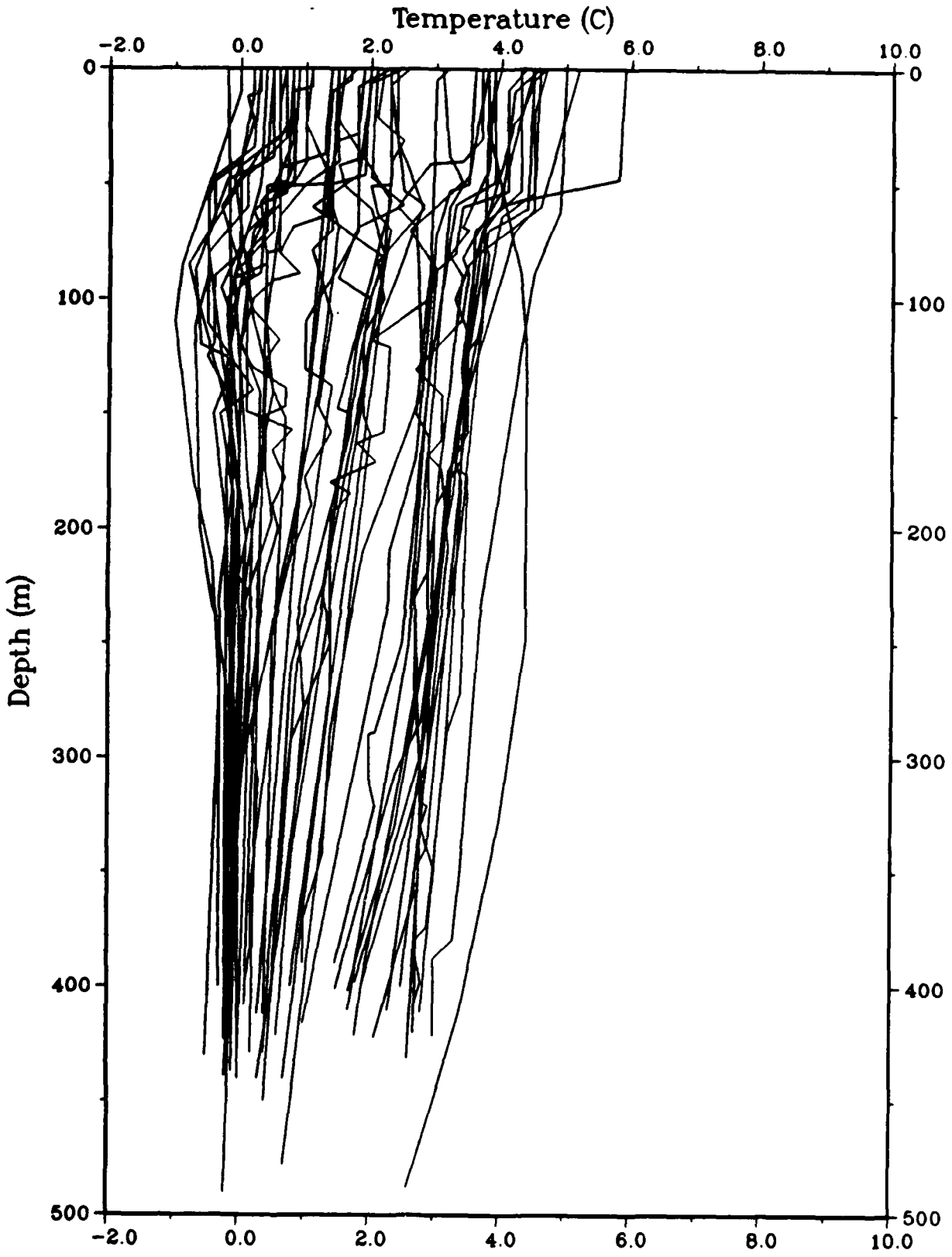
Jan Mayen Frontal Zone Survey

20 May 1987

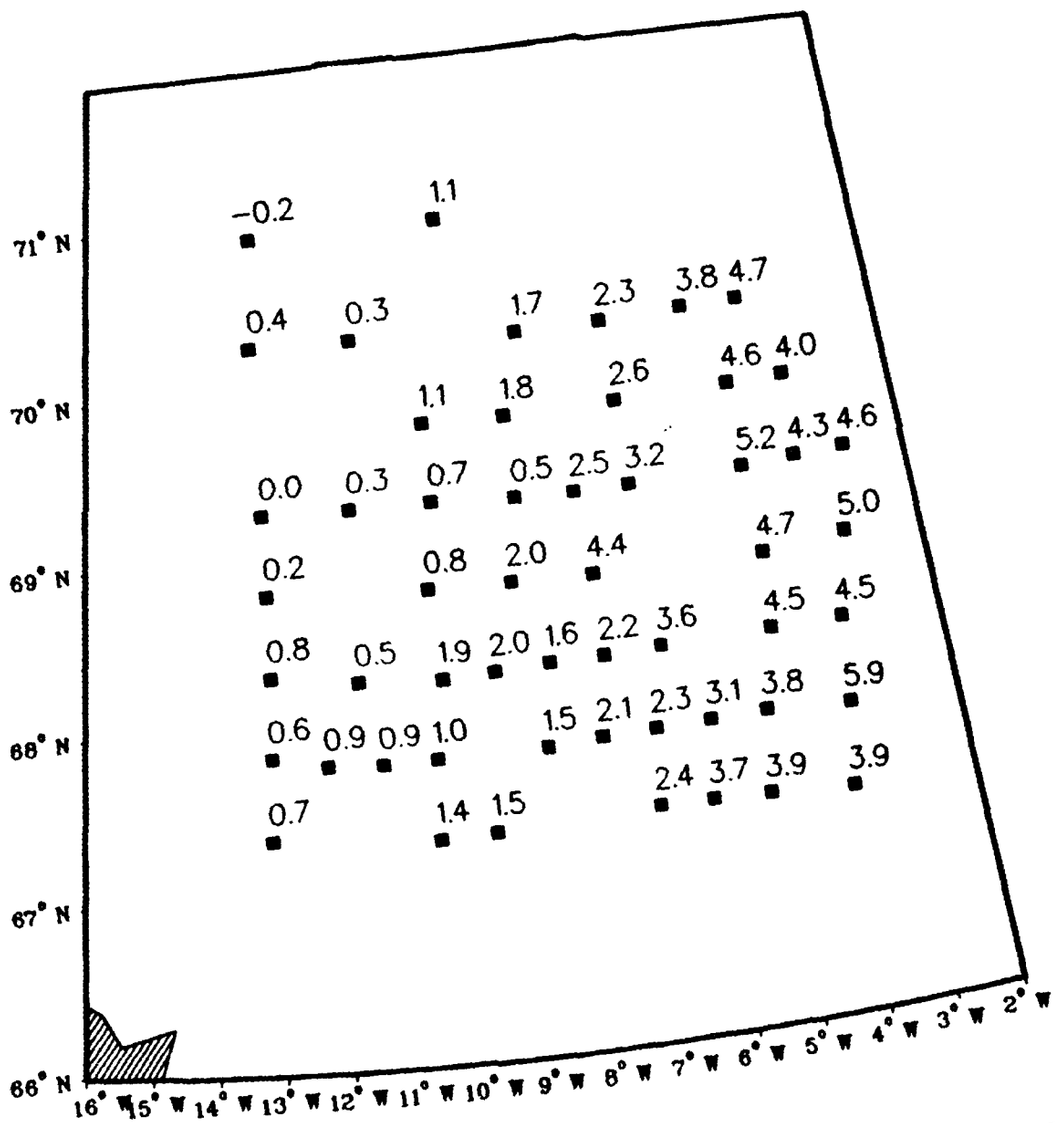
20 May 1987
AXBT Stations



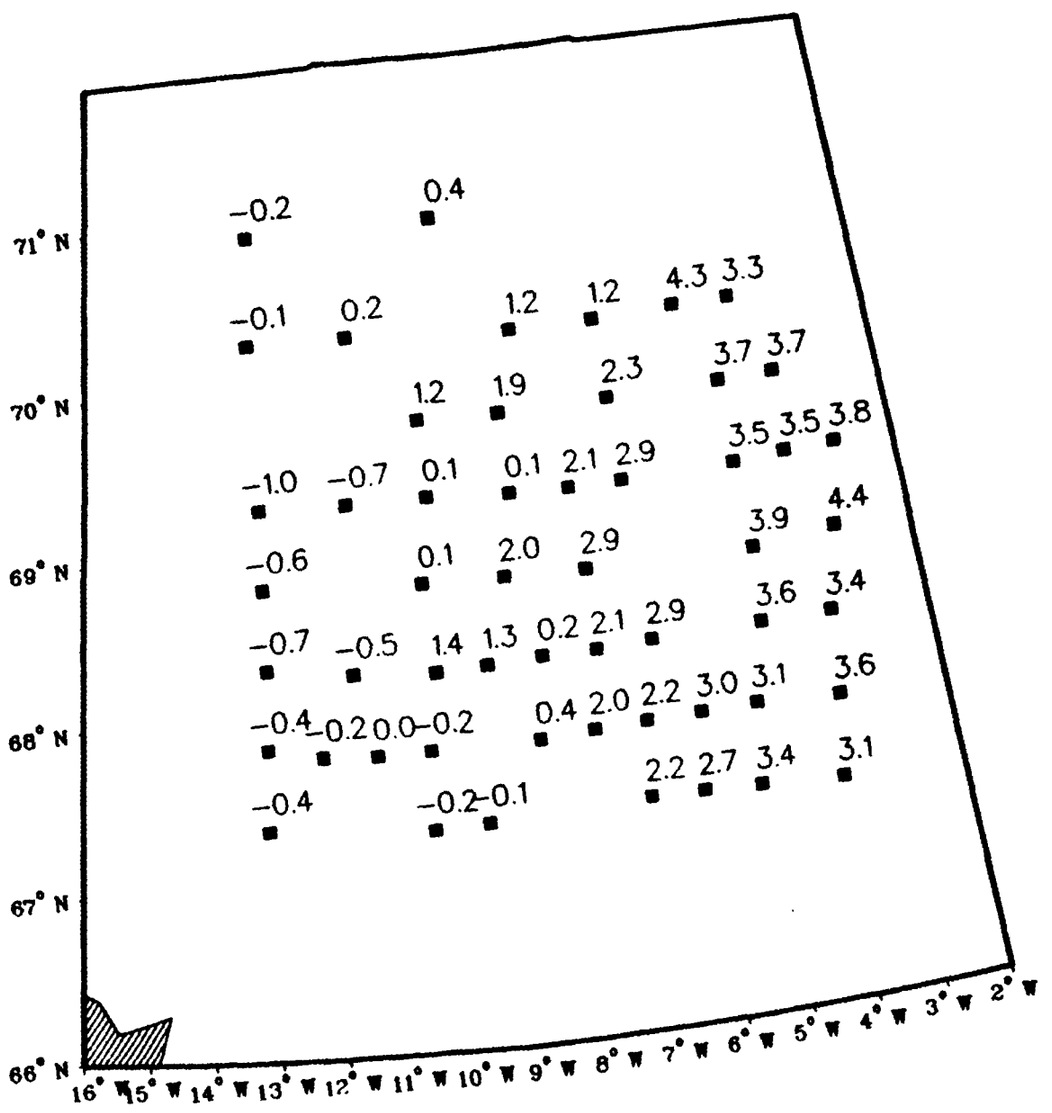
20 May 1987



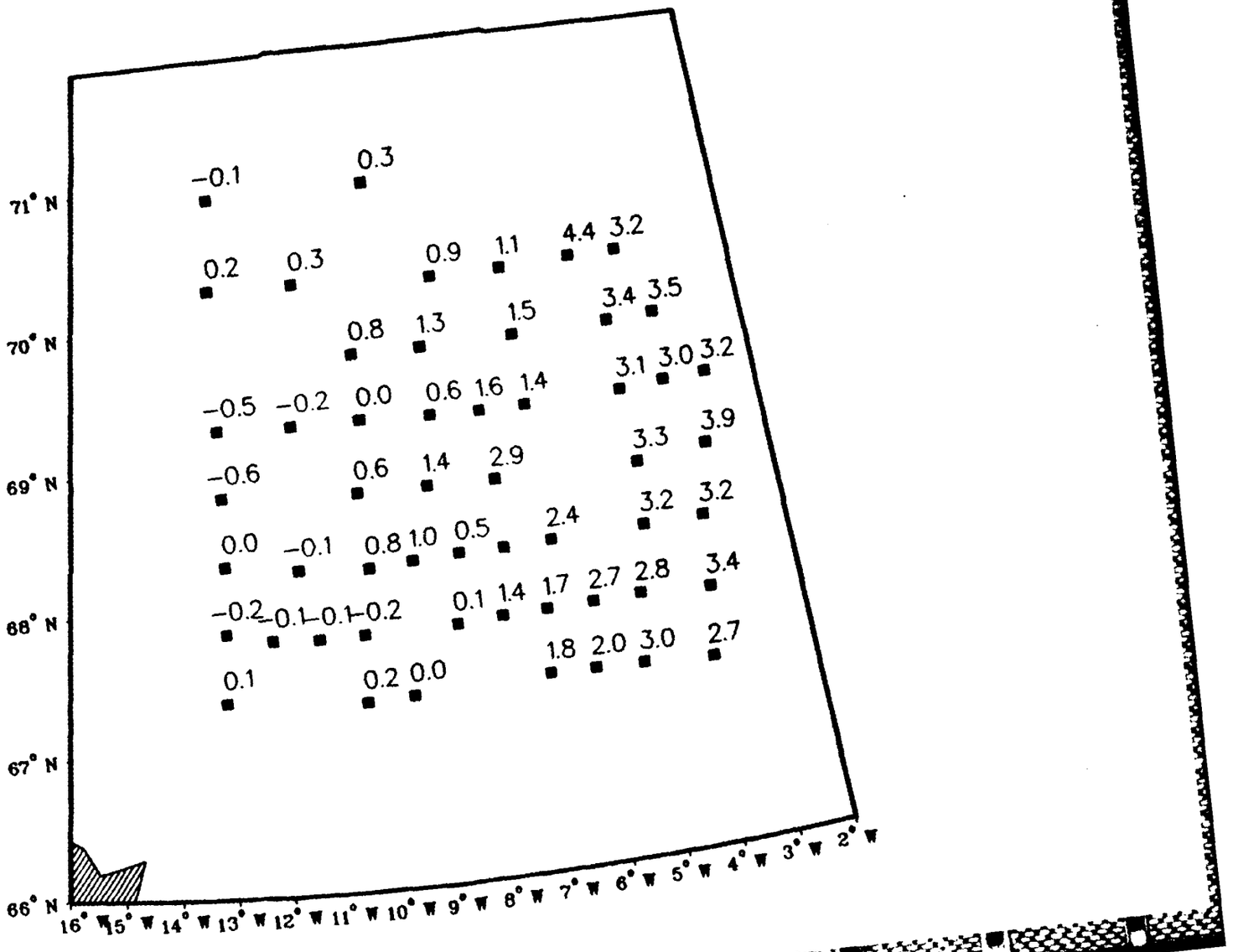
20 May 1987
0 meters



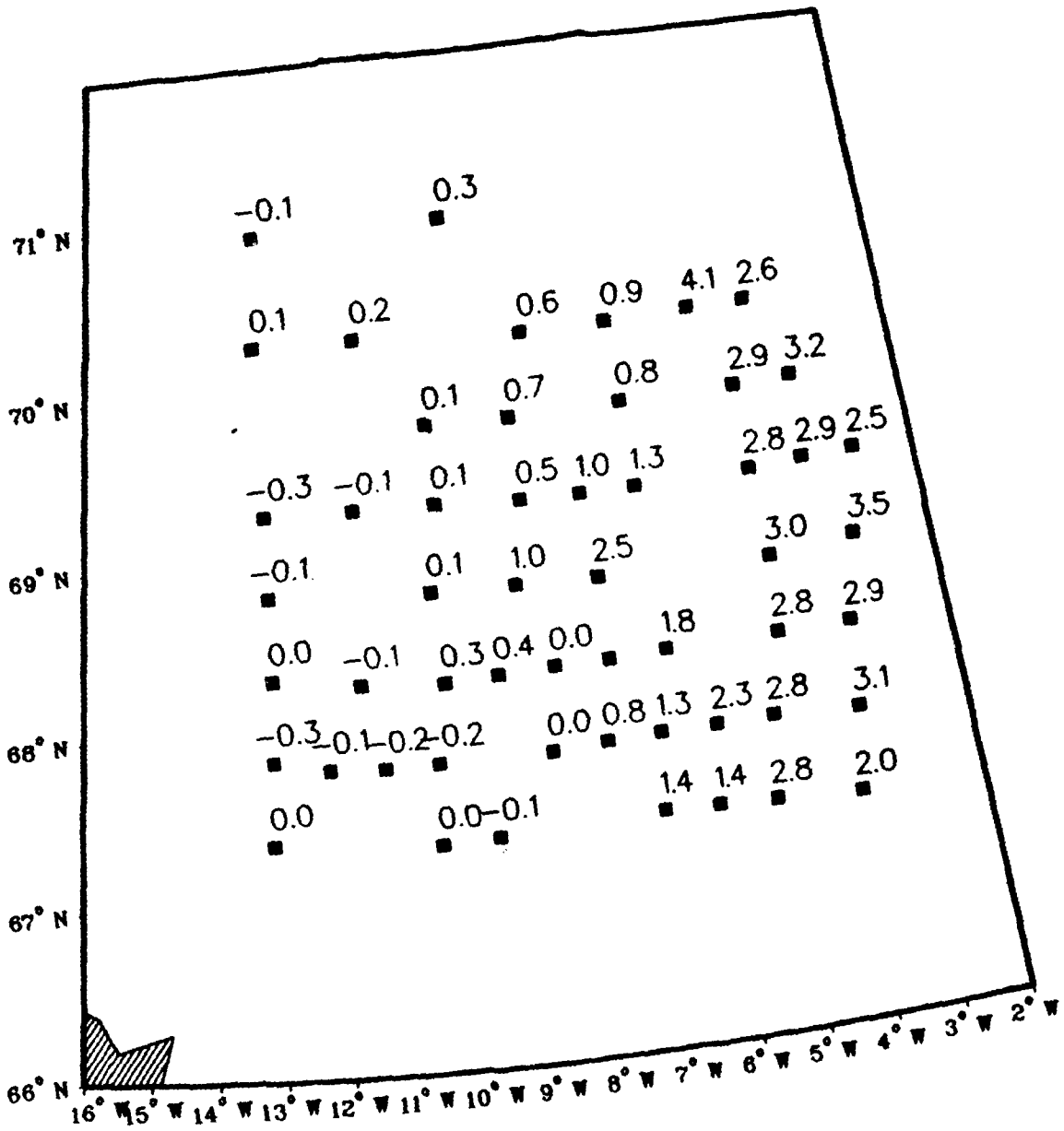
20 May 1987
100 meters



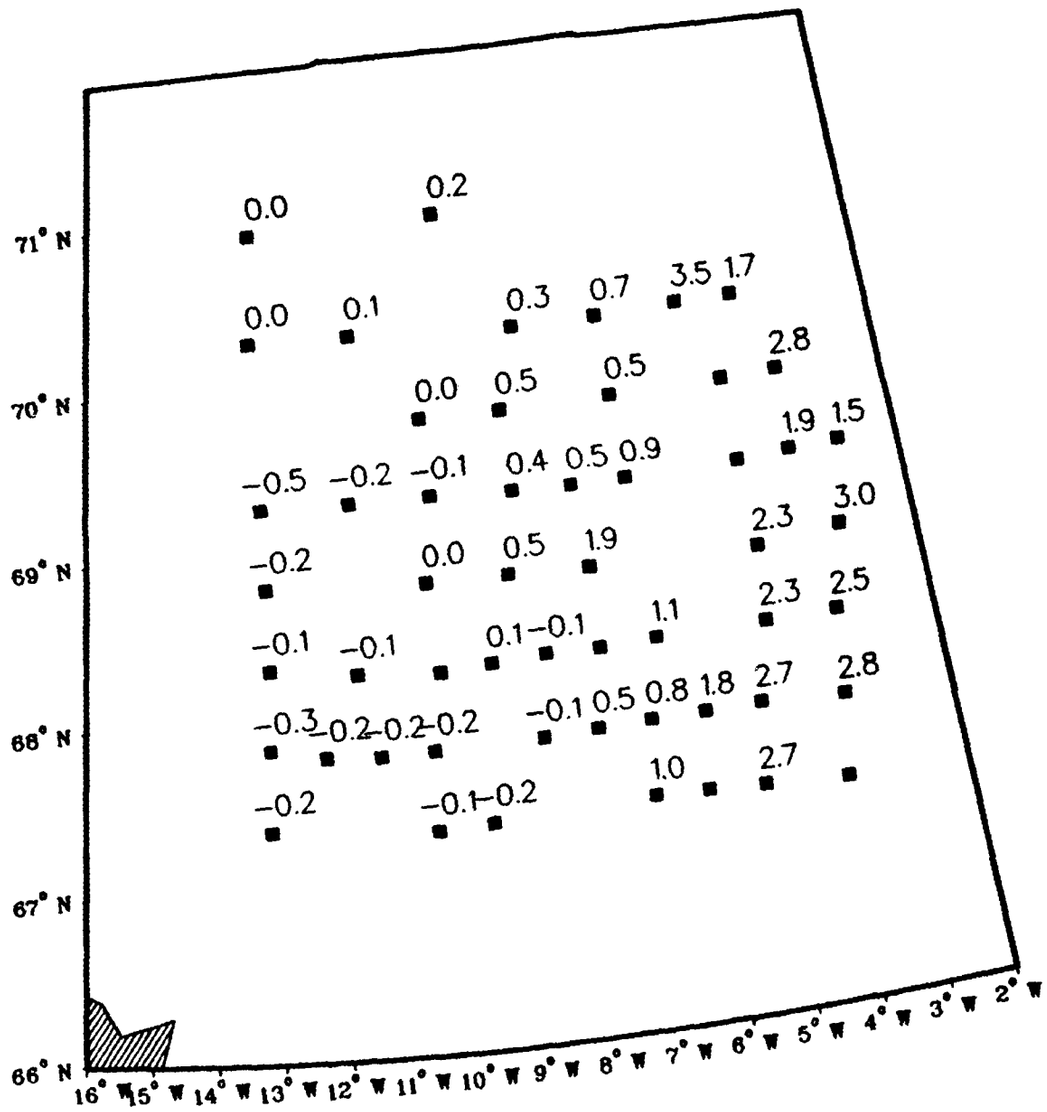
20 May 1987
200 meters



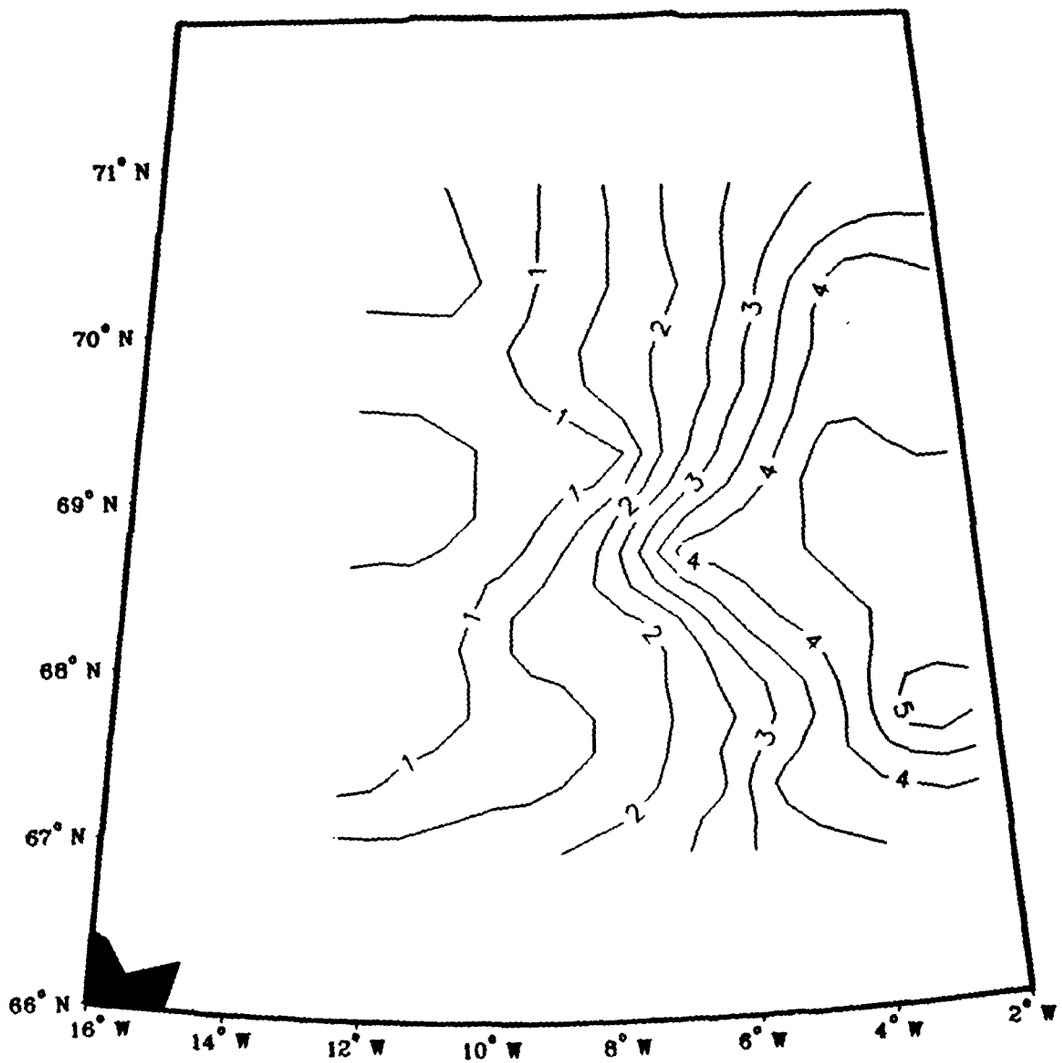
20 May 1987
300 meters



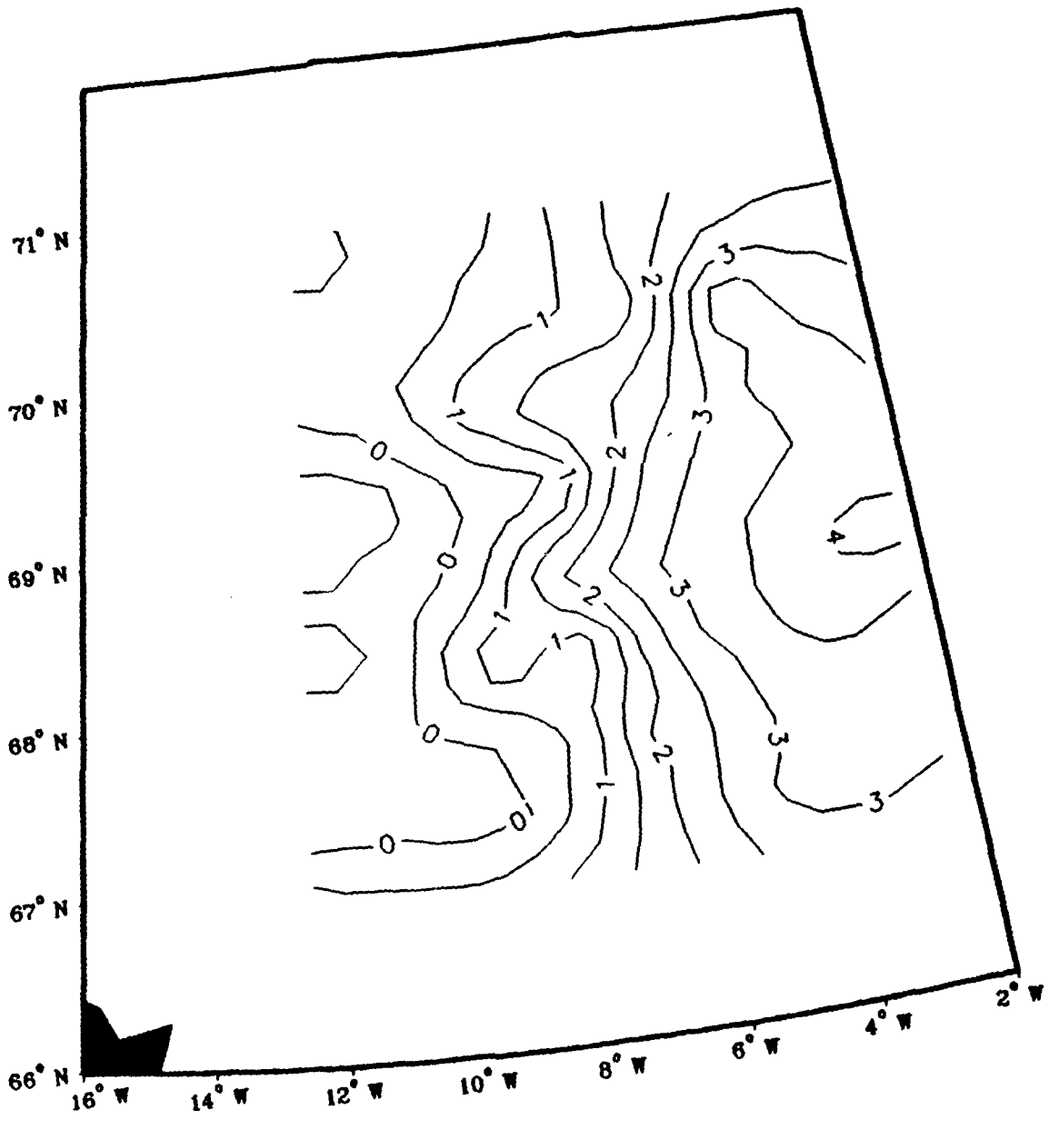
20 May 1987
400 meters



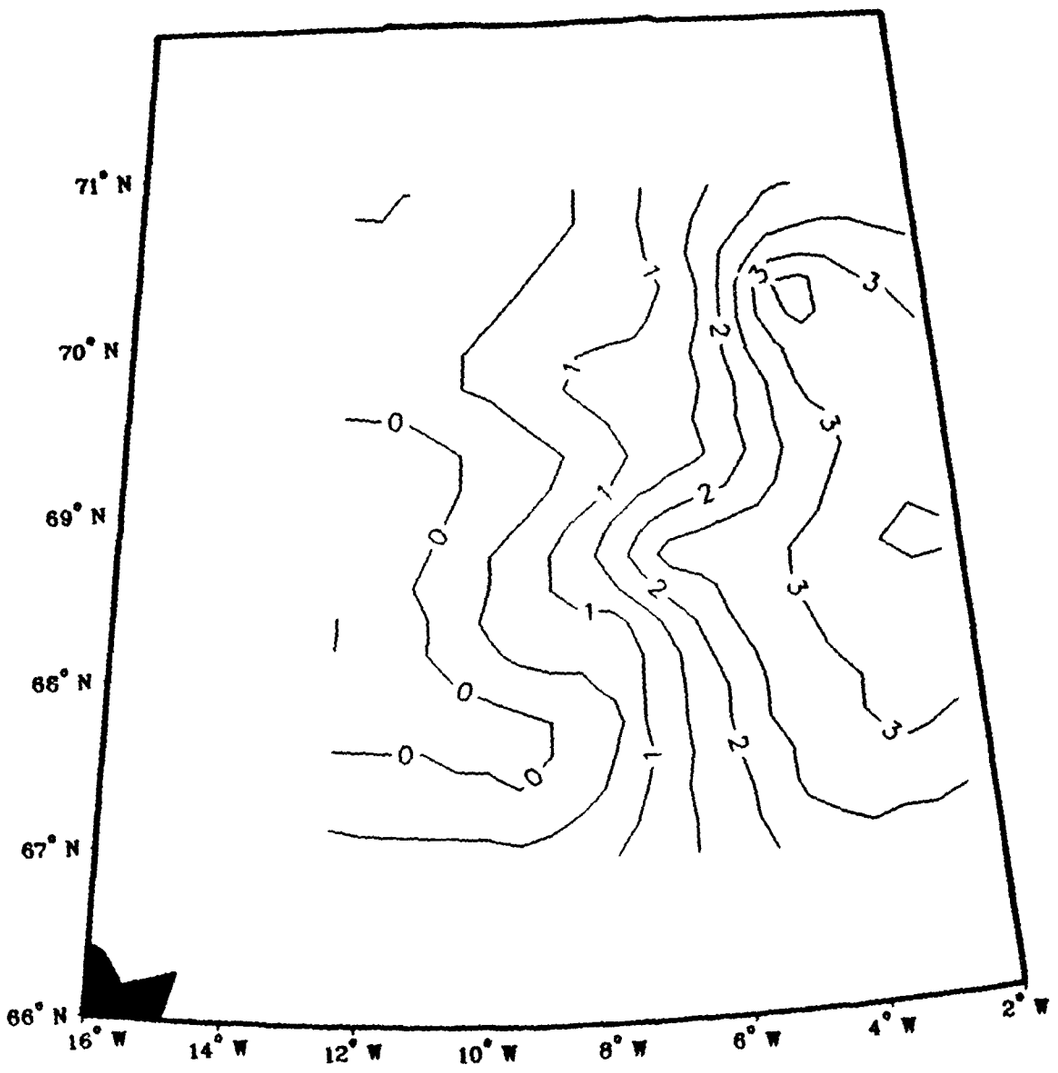
Temperature
20 May 1987
0 meters



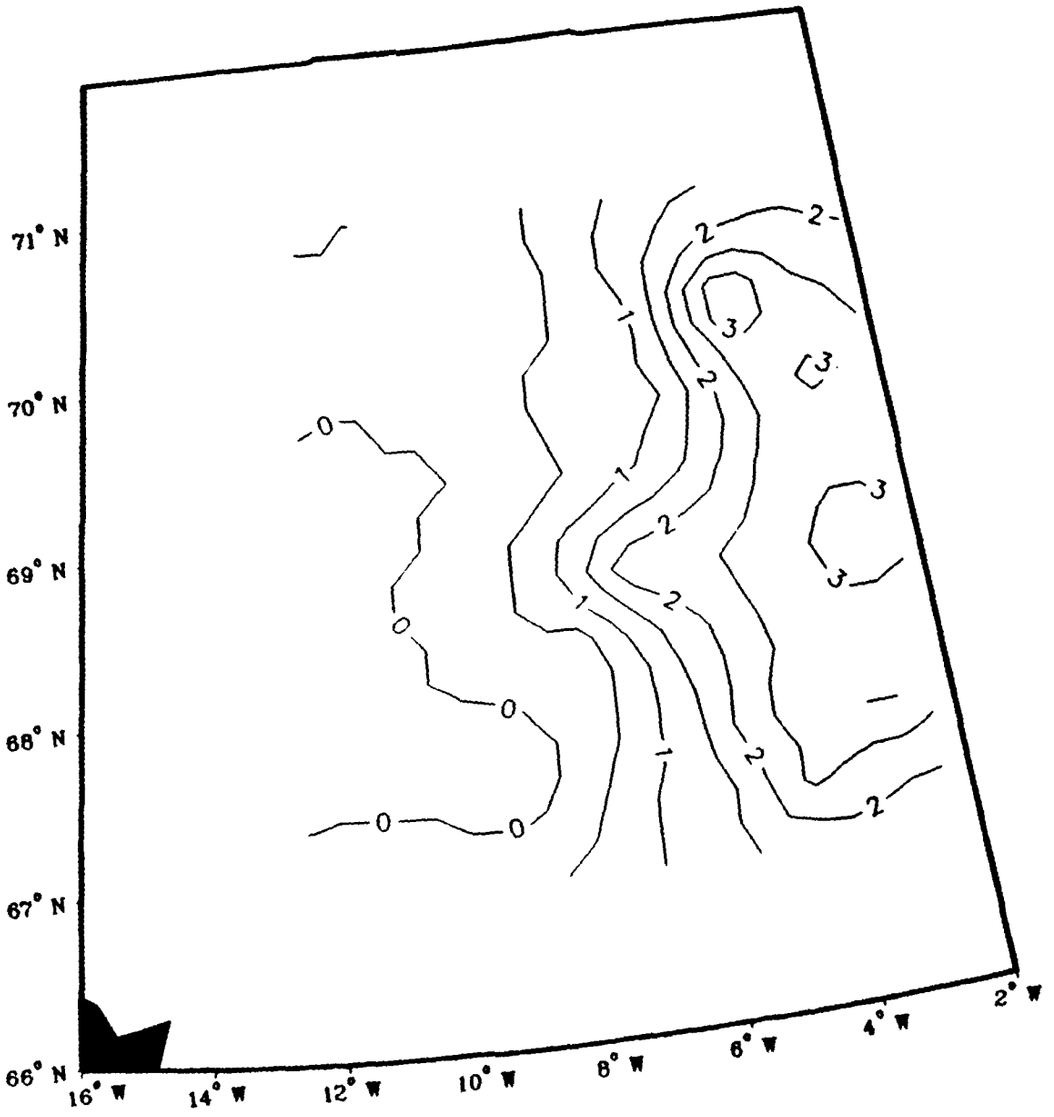
Temperature
20 May 1987
100 meters



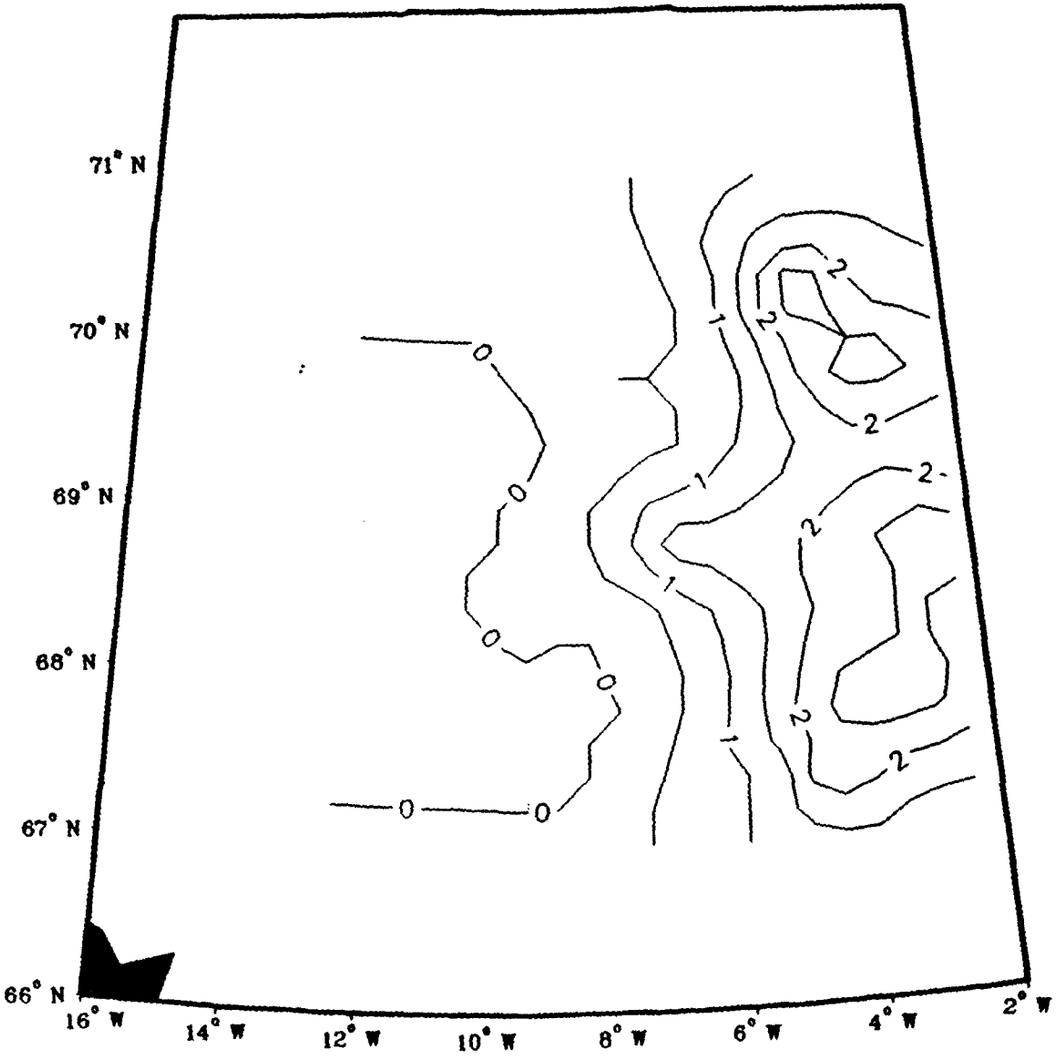
Temperature
20 May 1987
200 meters



Temperature
20 May 1987
300 meters



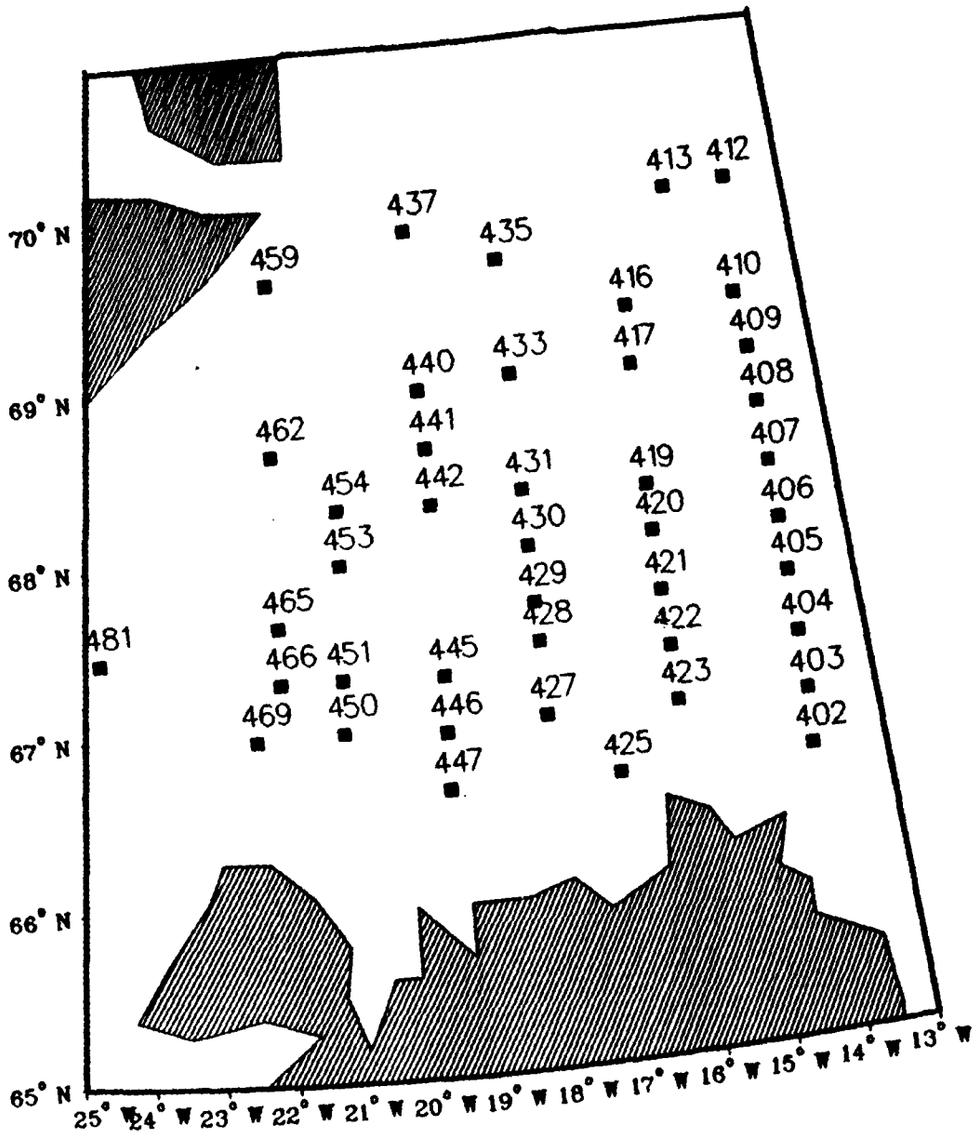
Temperature
20 May 1987
400 meters



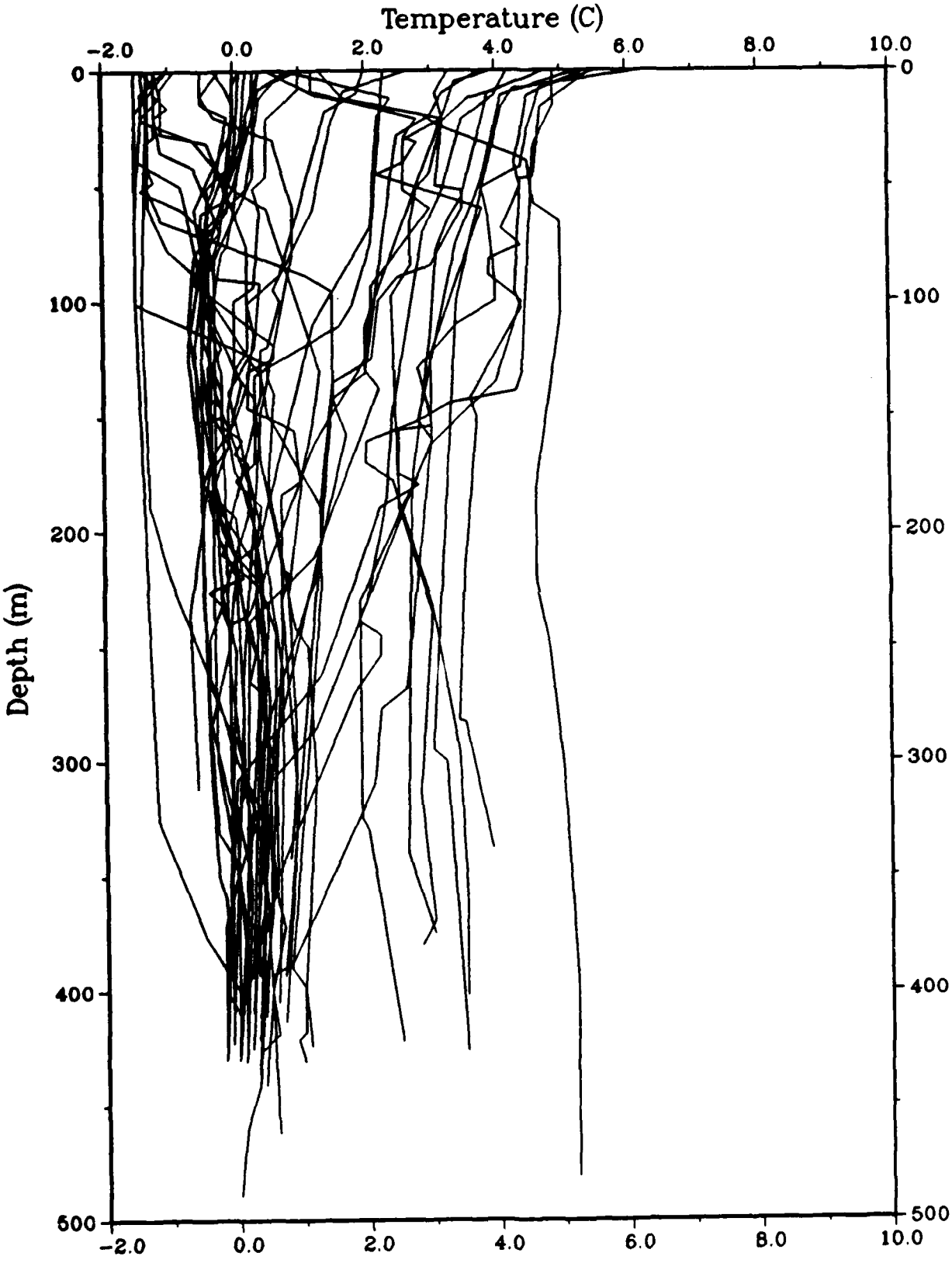
[illegible] Sea Survey

[illegible] May 1987

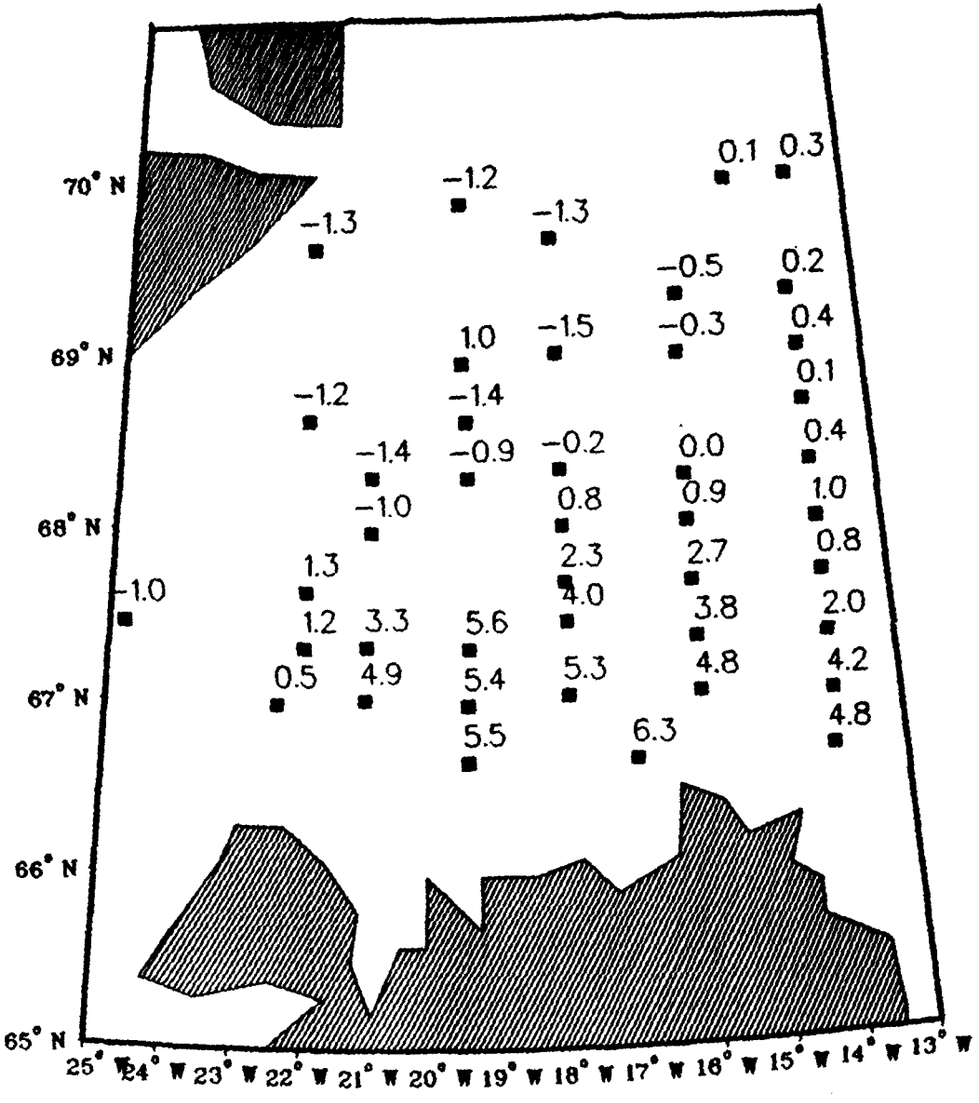
24 May 1987
AXBT Stations



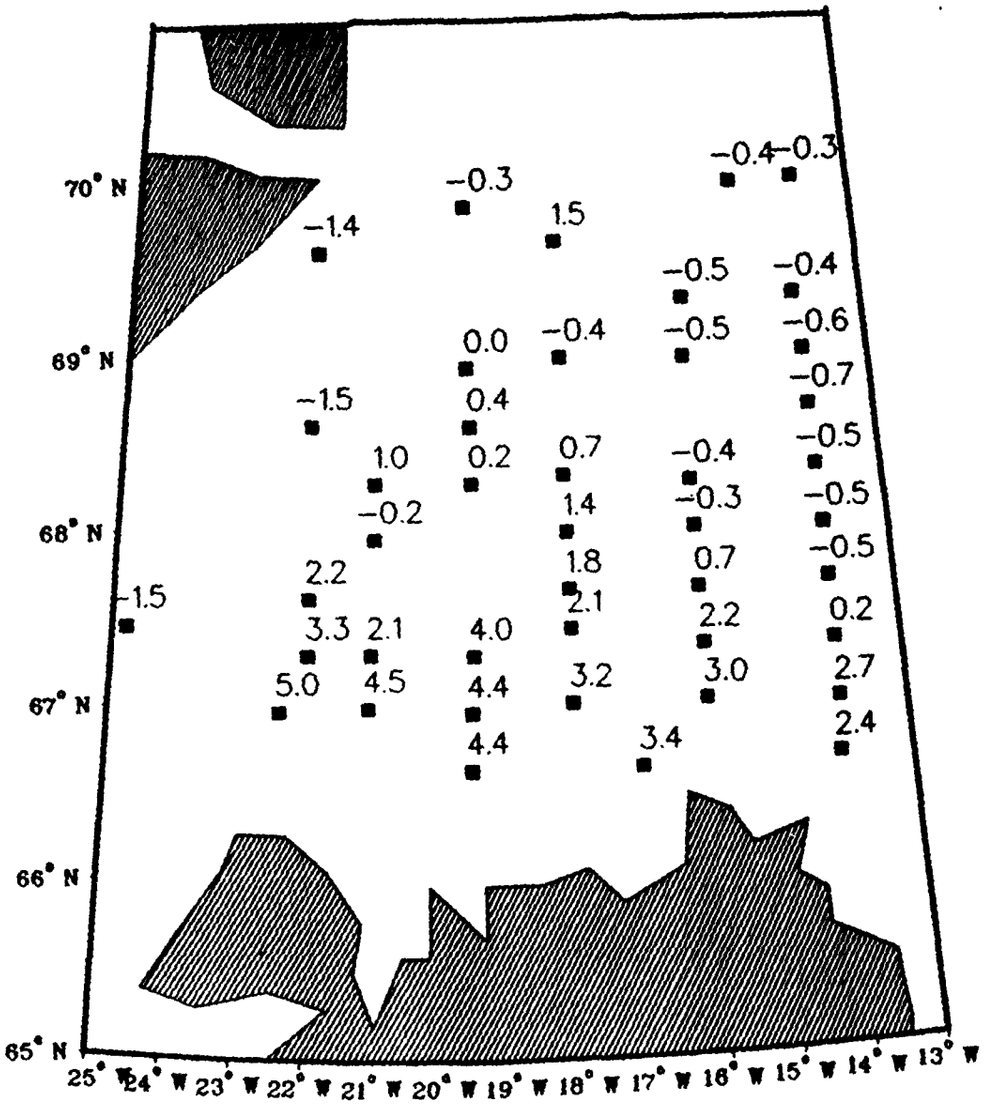
24 May 1987



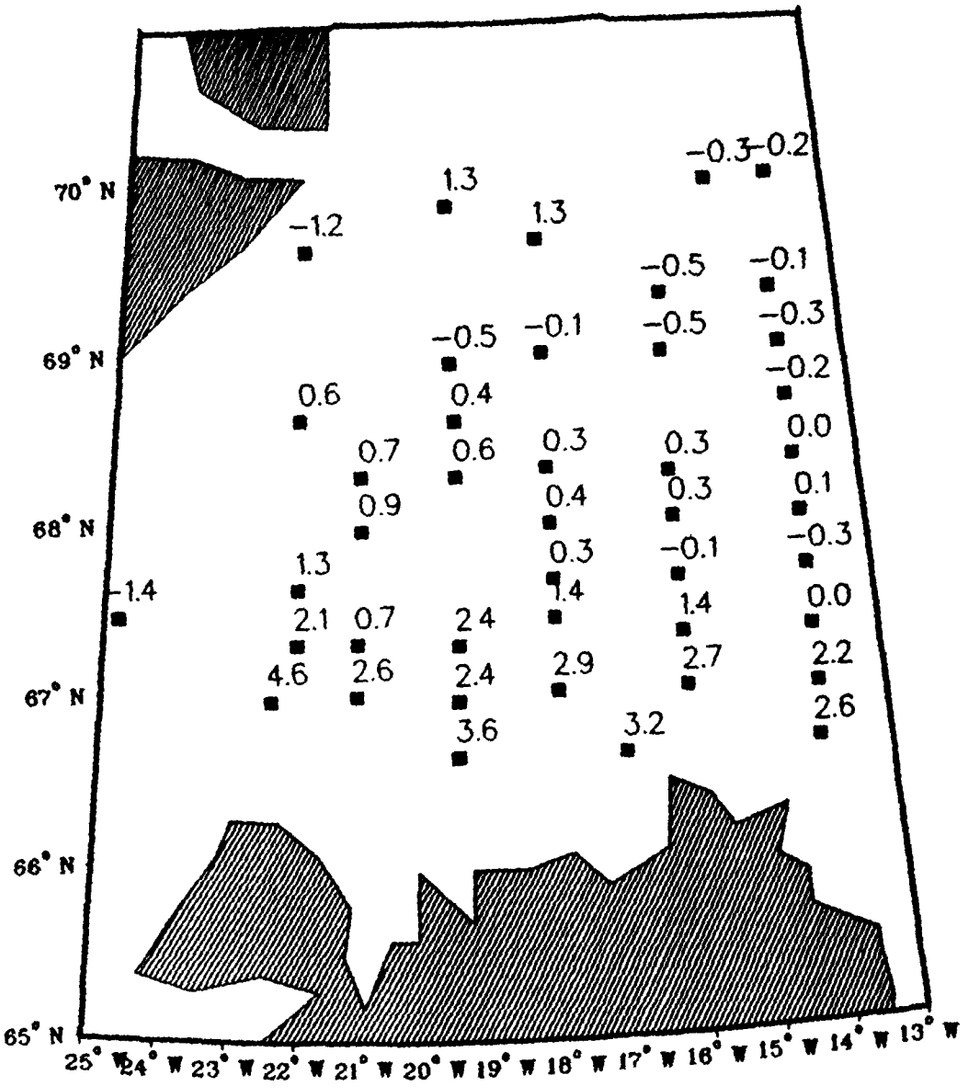
24 May 1987
0 meters



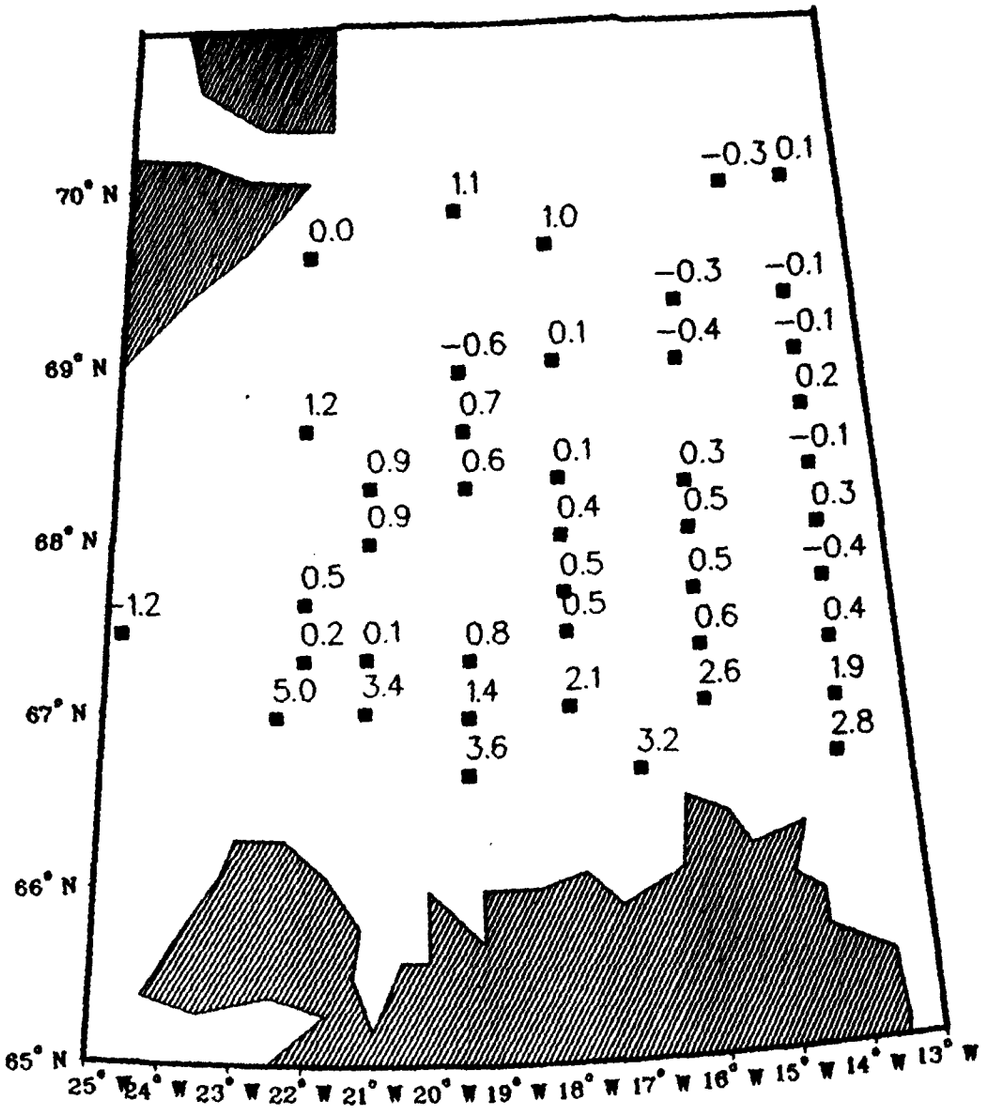
24 May 1987
100 meters



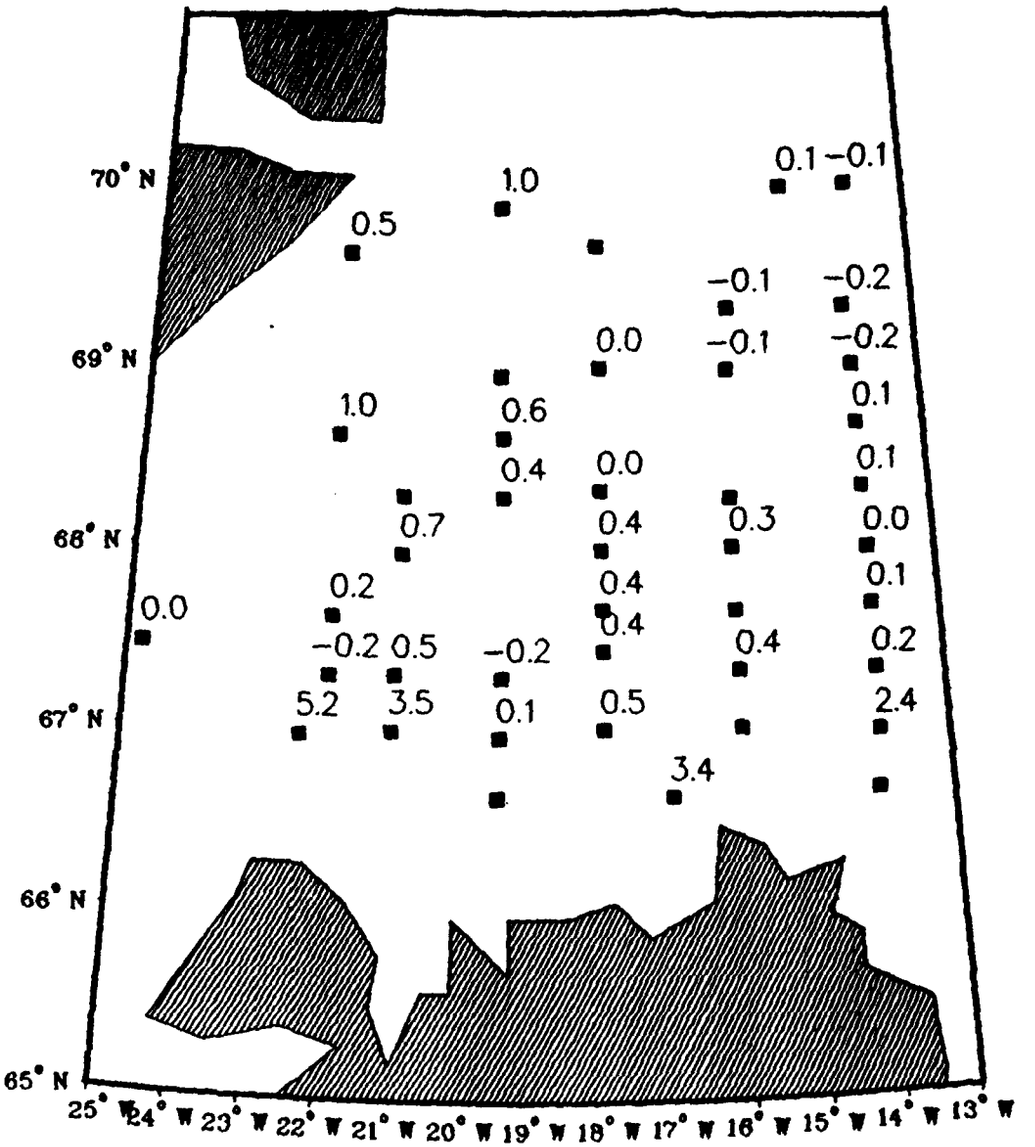
24 May 1987
200 meters



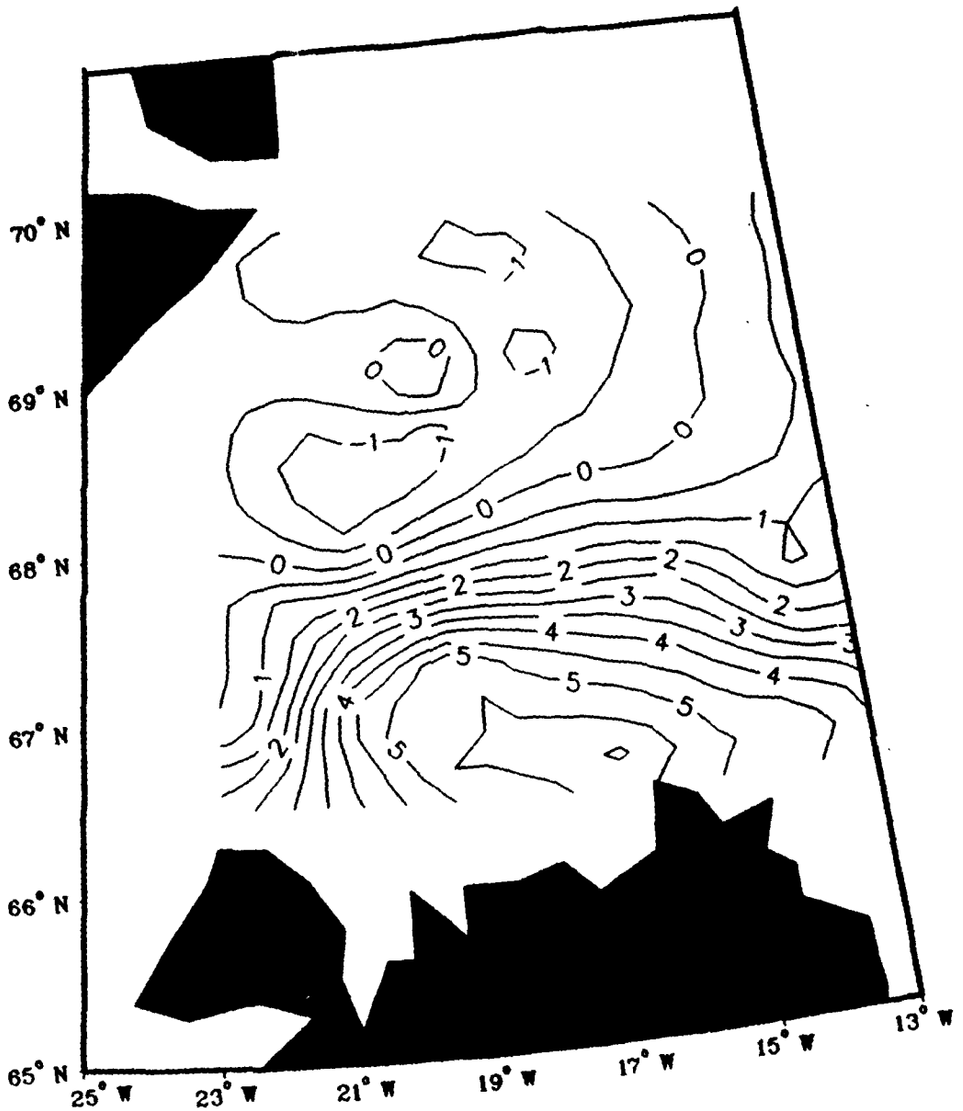
24 May 1987
300 meters



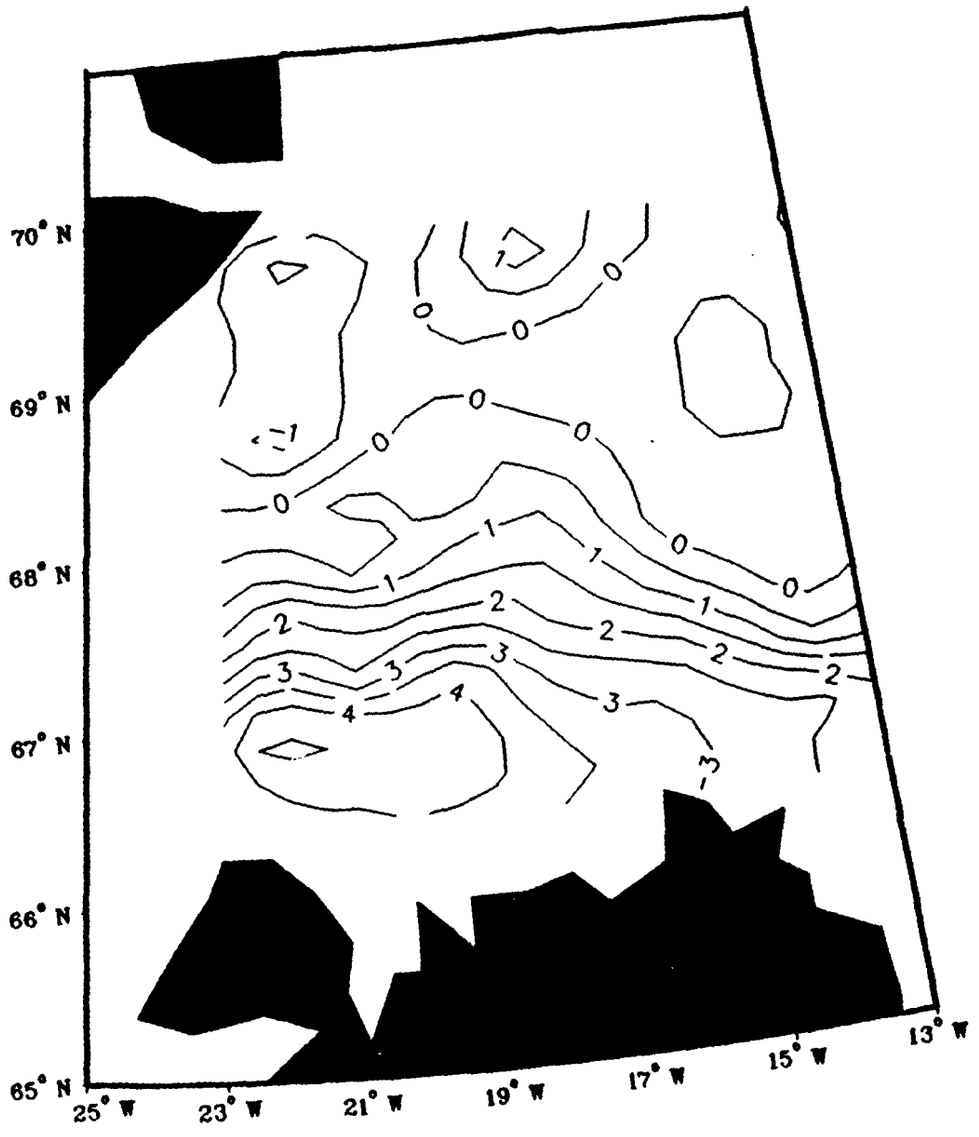
24 May 1987
400 meters



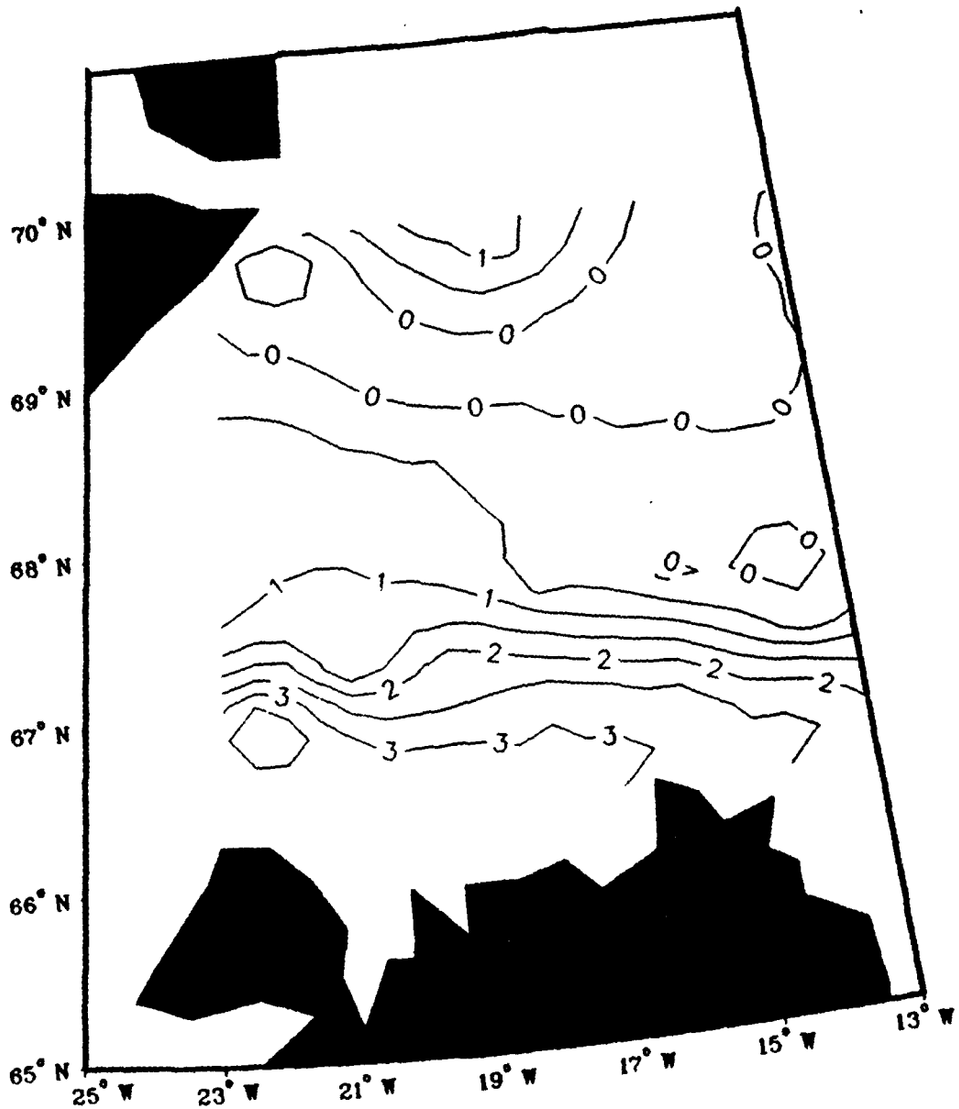
Temperature
24 May 1987
0 meters



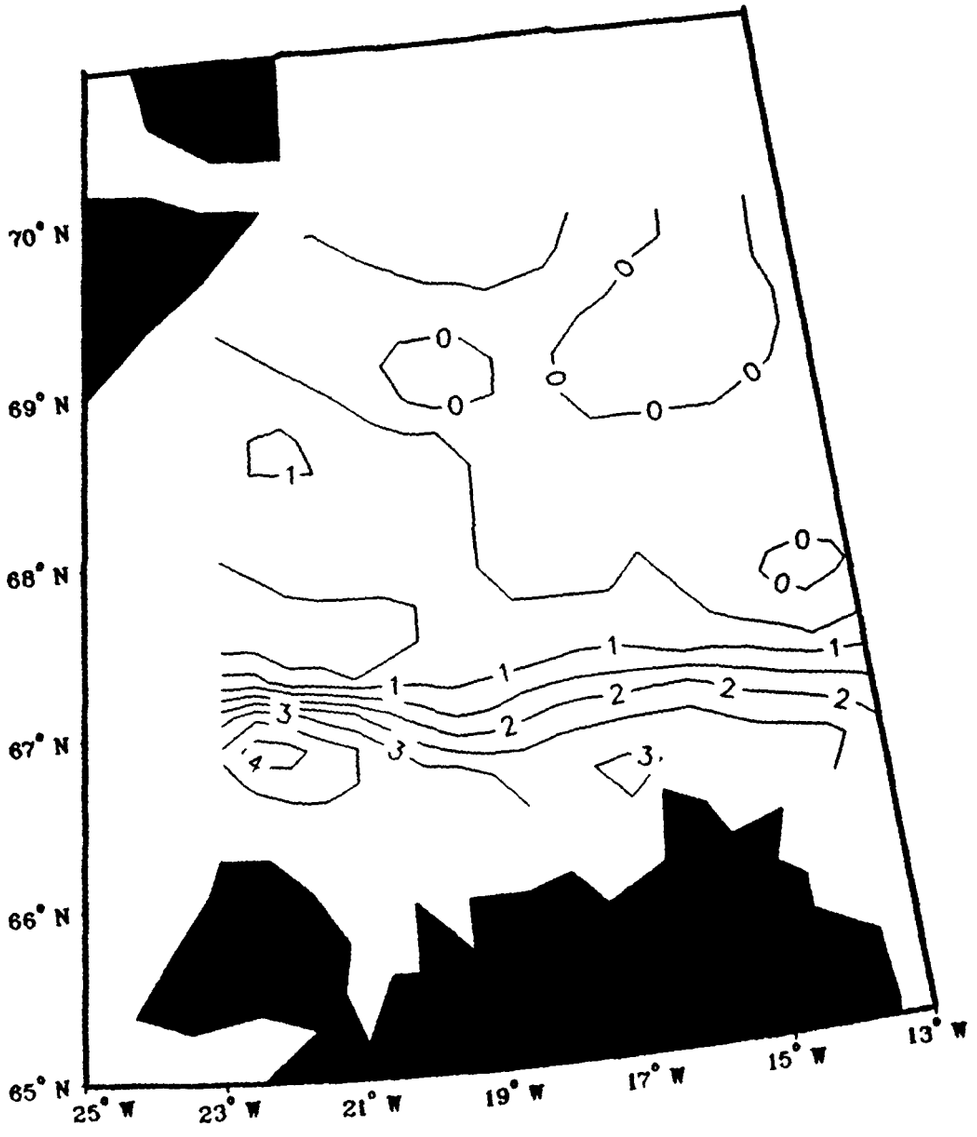
Temperature
24 May 1987
100 meters



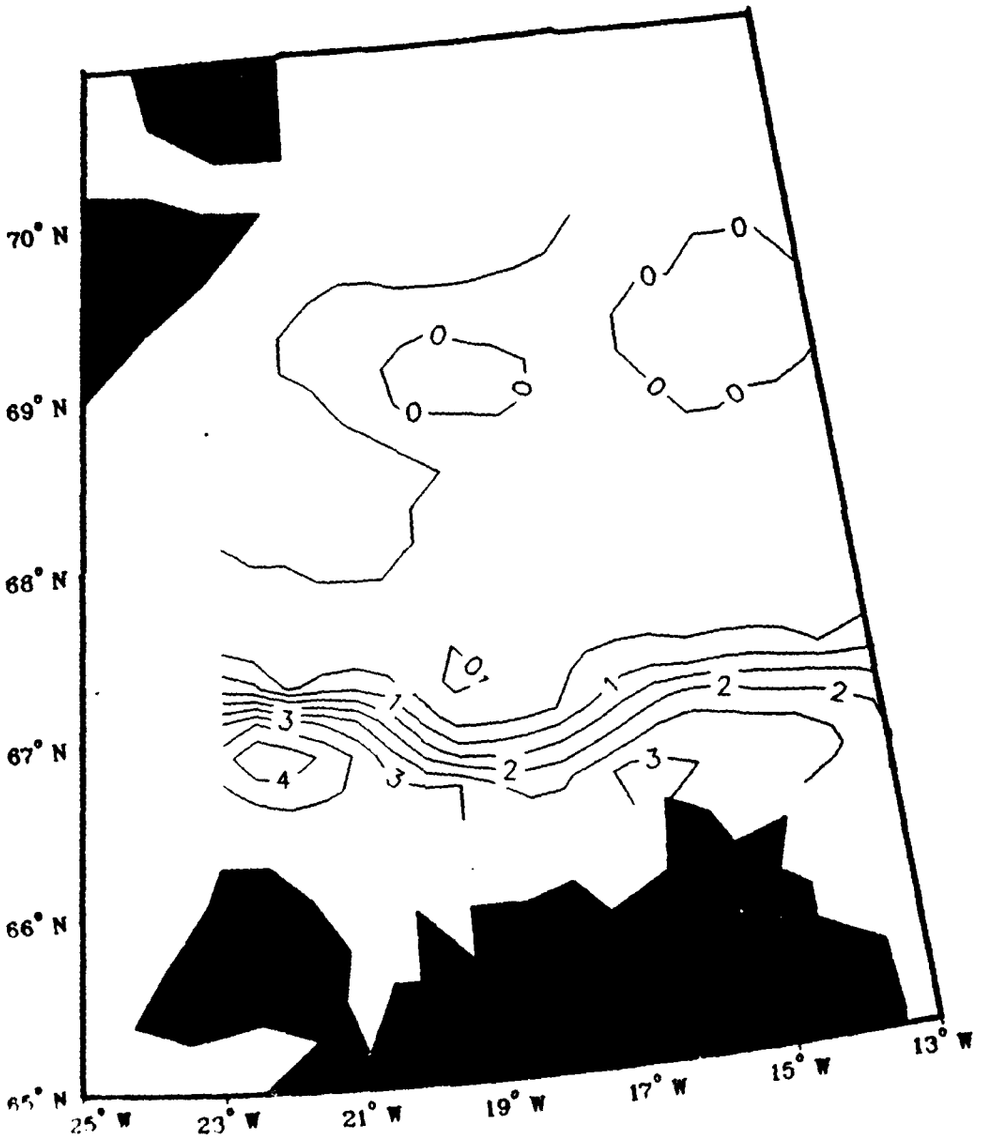
Temperature
24 May 1987
200 meters



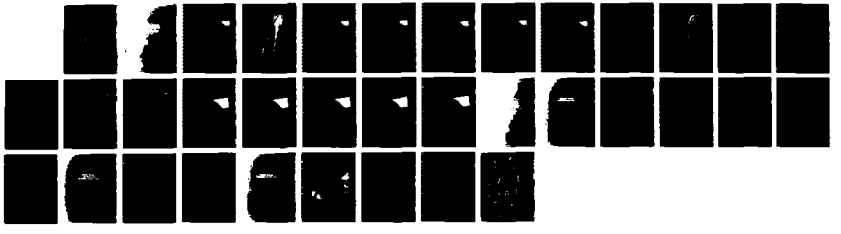
Temperature
24 May 1987
300 meters

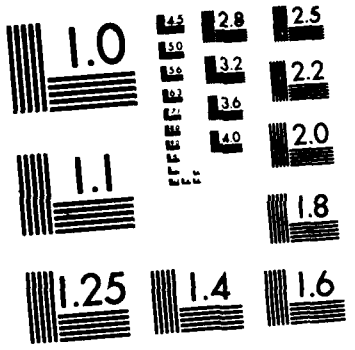


Temperature
24 May 1987
400 meters

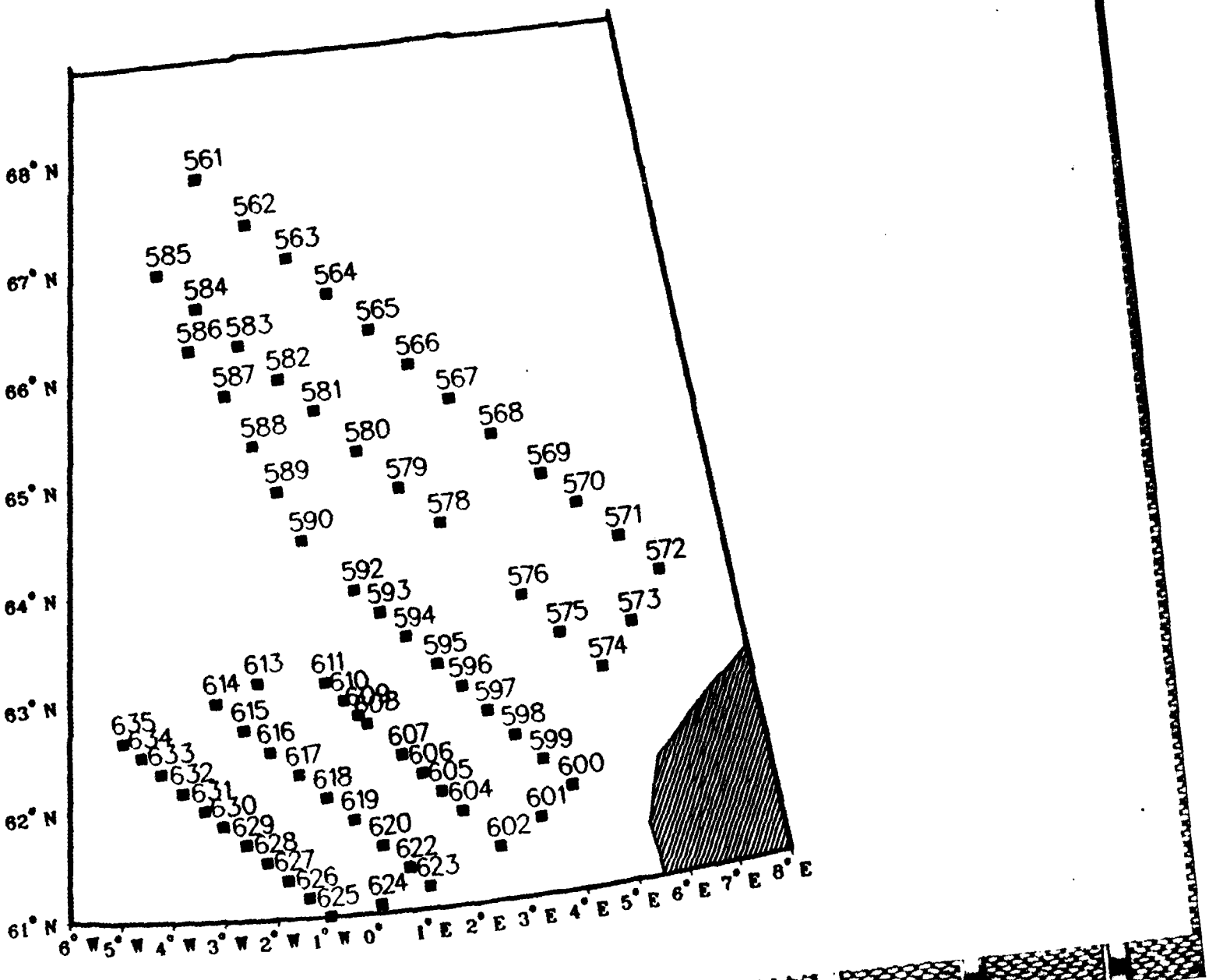


AD-A191 961 ENVIRONMENTAL CONDITIONS IN THE NORWEGIAN-ICELAND SEAS 2/2
MAY 1987(U) NAVAL OCEAN RESEARCH AND DEVELOPMENT
ACTIVITY NSTL STATION MS J D BOYD ET AL. JUN 87
UNCLASSIFIED NORDA-TN-341 F/G 8/3 NL

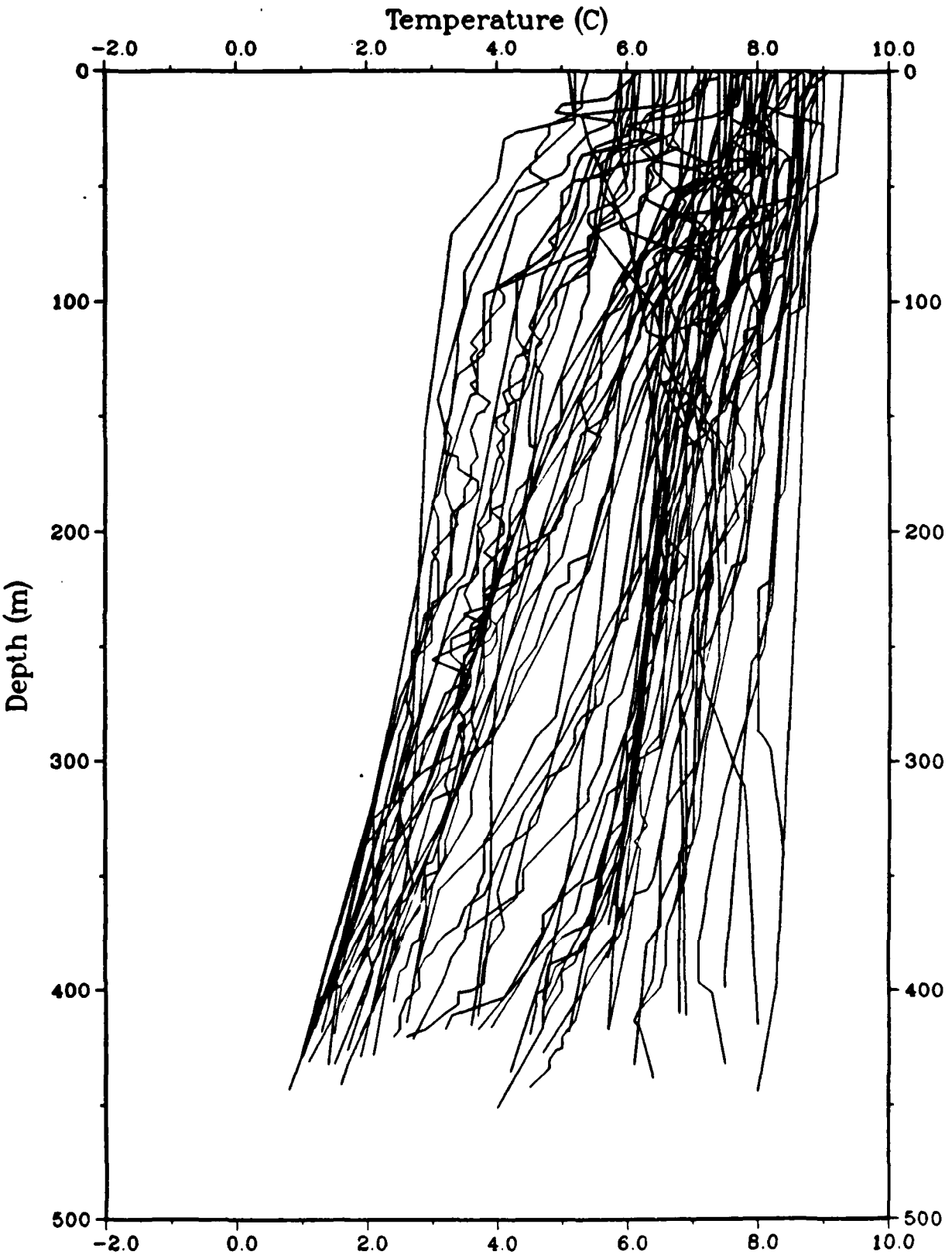


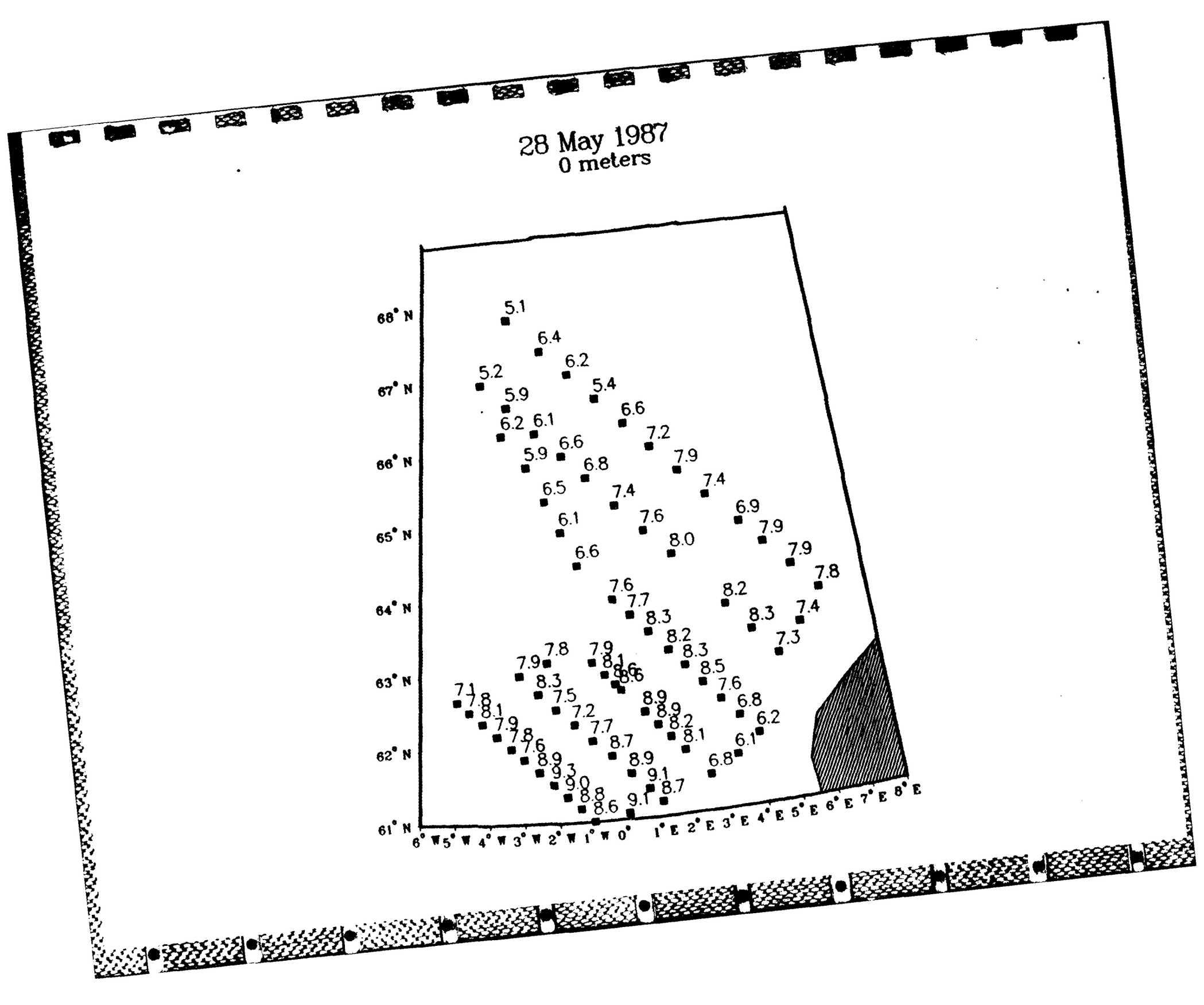


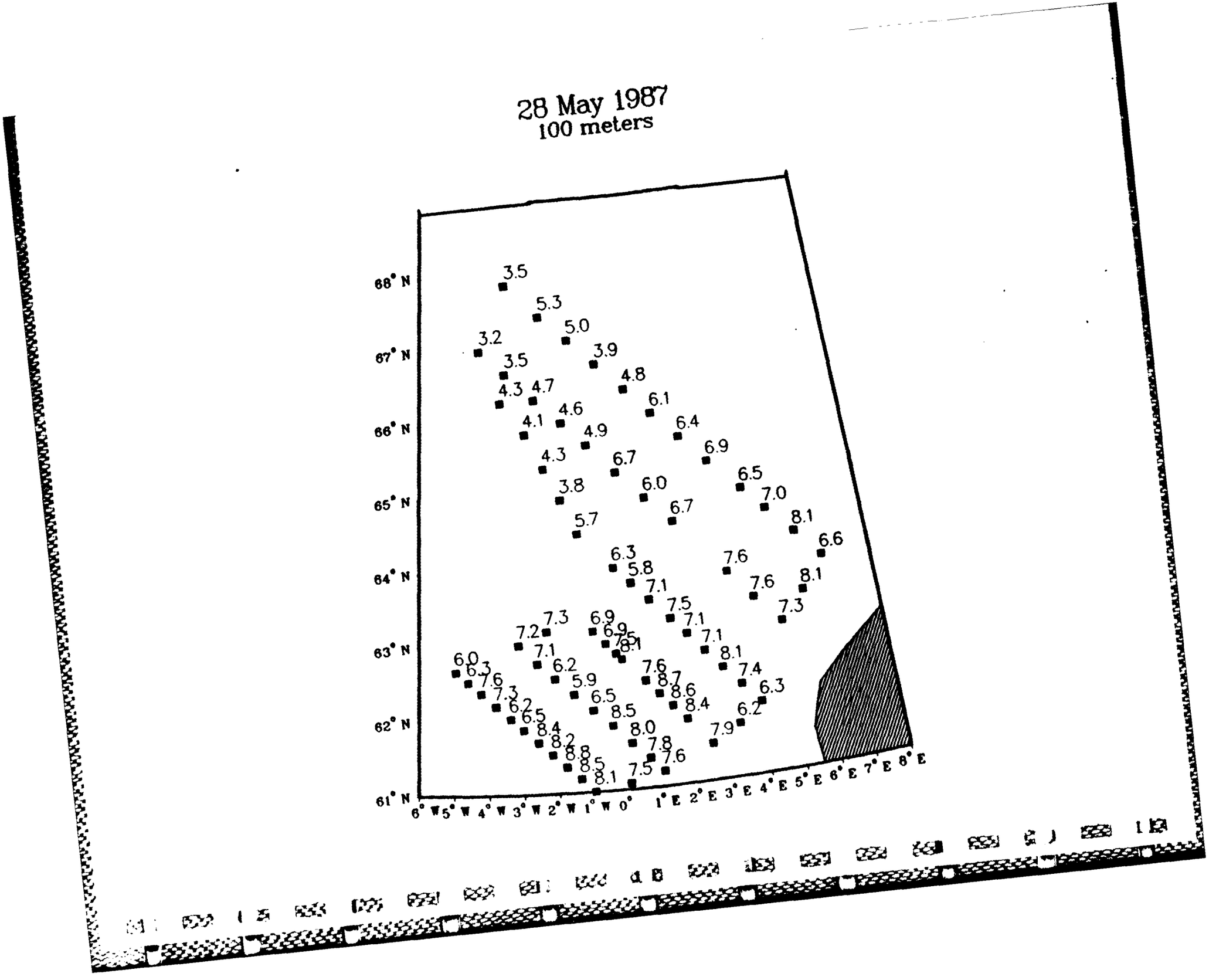
28 May 87
AXBT Stations

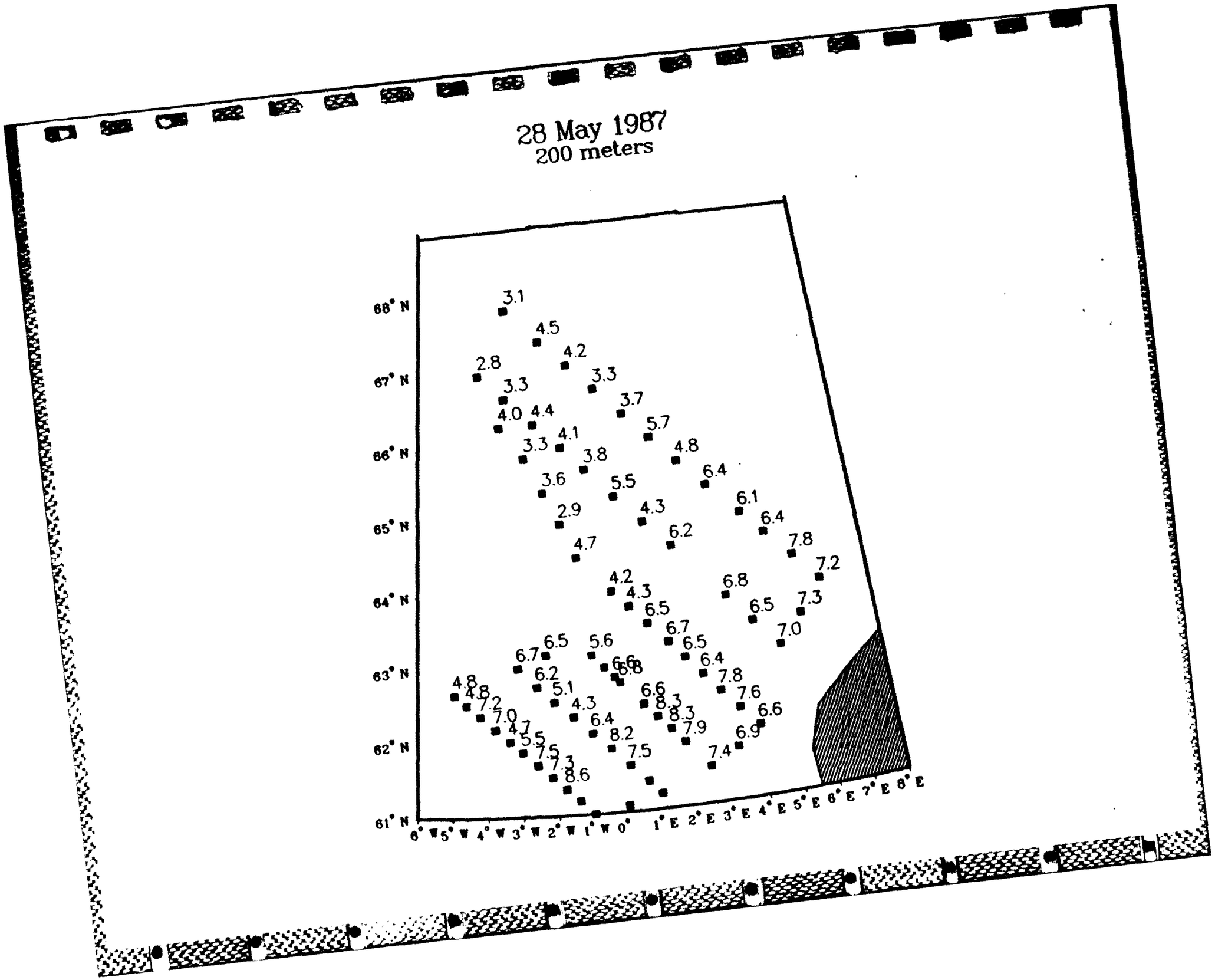


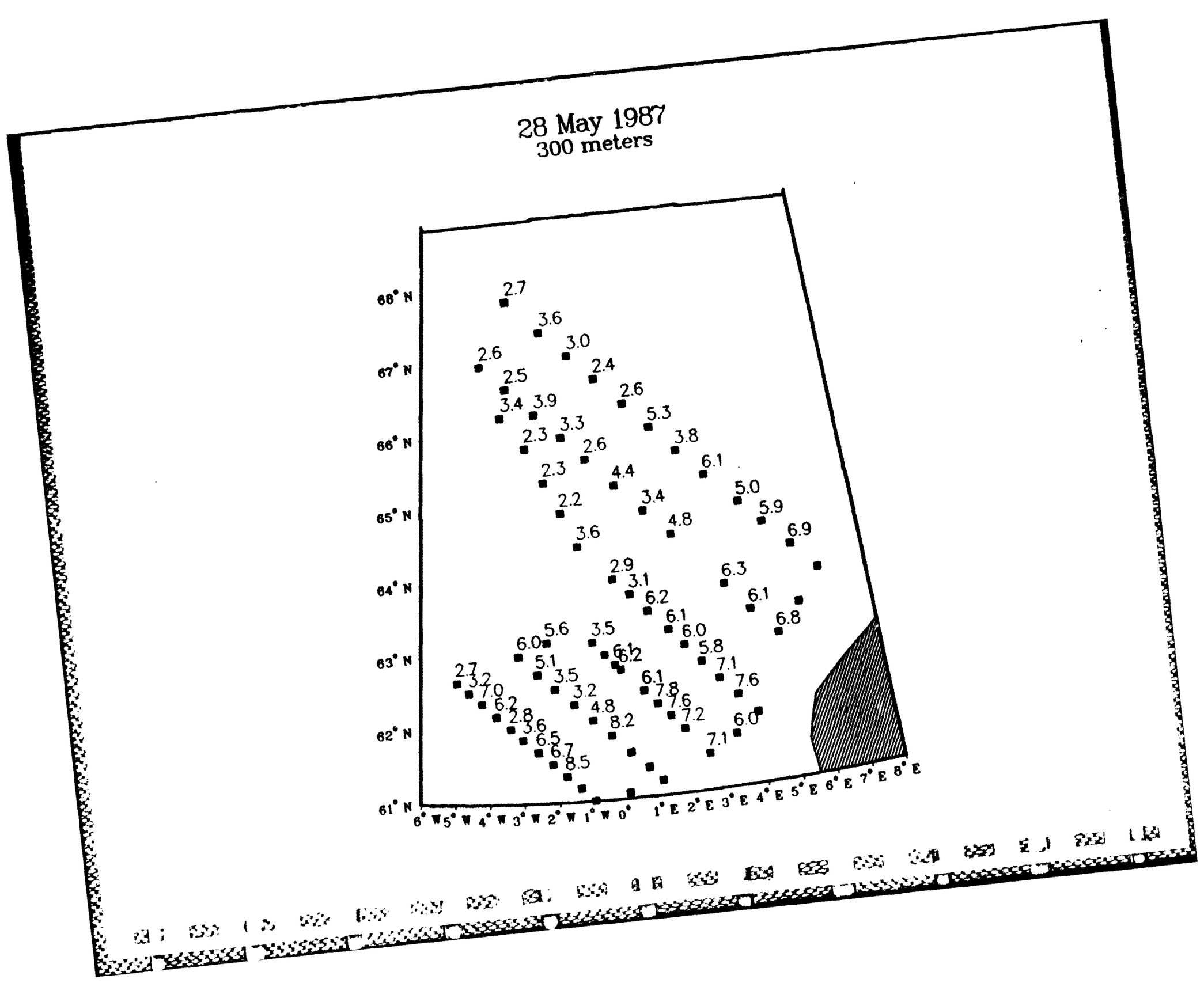
28 May 1987

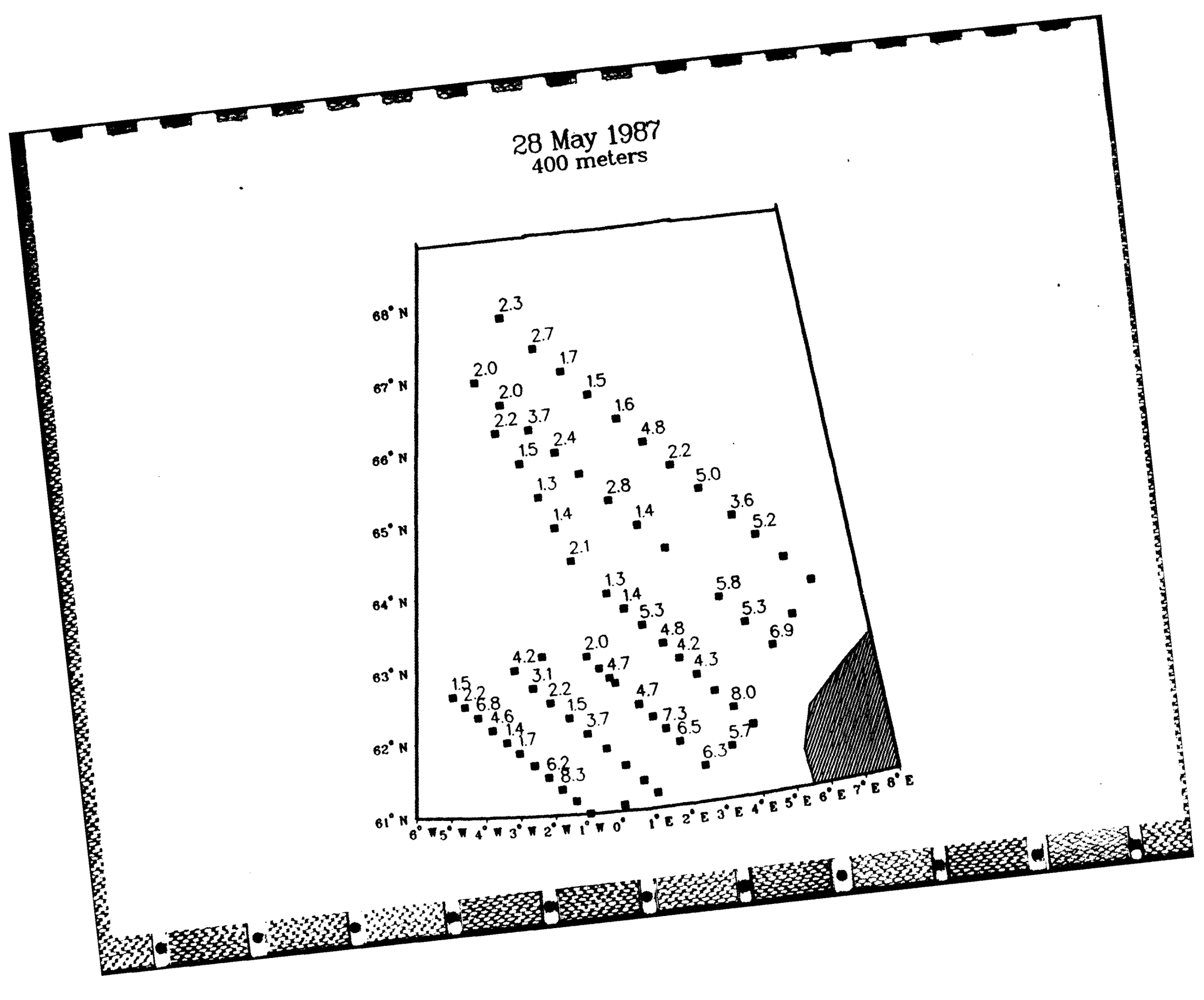



28 May 1987
0 meters
68° N
67° N
66° N
65° N
64° N
63° N
62° N
61° N
6° W 5° W 4° W 3° W 2° W 1° W 0° 1° E 2° E 3° E 4° E 5° E 6° E 7° E 8° E
5.1
6.4
6.2
5.2
5.4
5.9
6.6
6.2 6.1
7.2
6.6
5.9
7.9
6.8
7.4
6.5
7.4
6.9
6.1
7.6
7.9
8.0
6.6
7.9
7.8
7.6
8.2
7.7
7.4
8.3
8.3
8.2
7.3
7.8
7.9
8.3
8.5
7.9
8.3
7.6
7.1
7.5
6.8
7.8
8.9
8.1
7.2
6.2
7.9
8.2
7.7
8.1
7.8
8.7
6.1
7.6
8.9
8.9
6.8
9.3
9.1
9.0
8.7
8.8
9.1
8.6

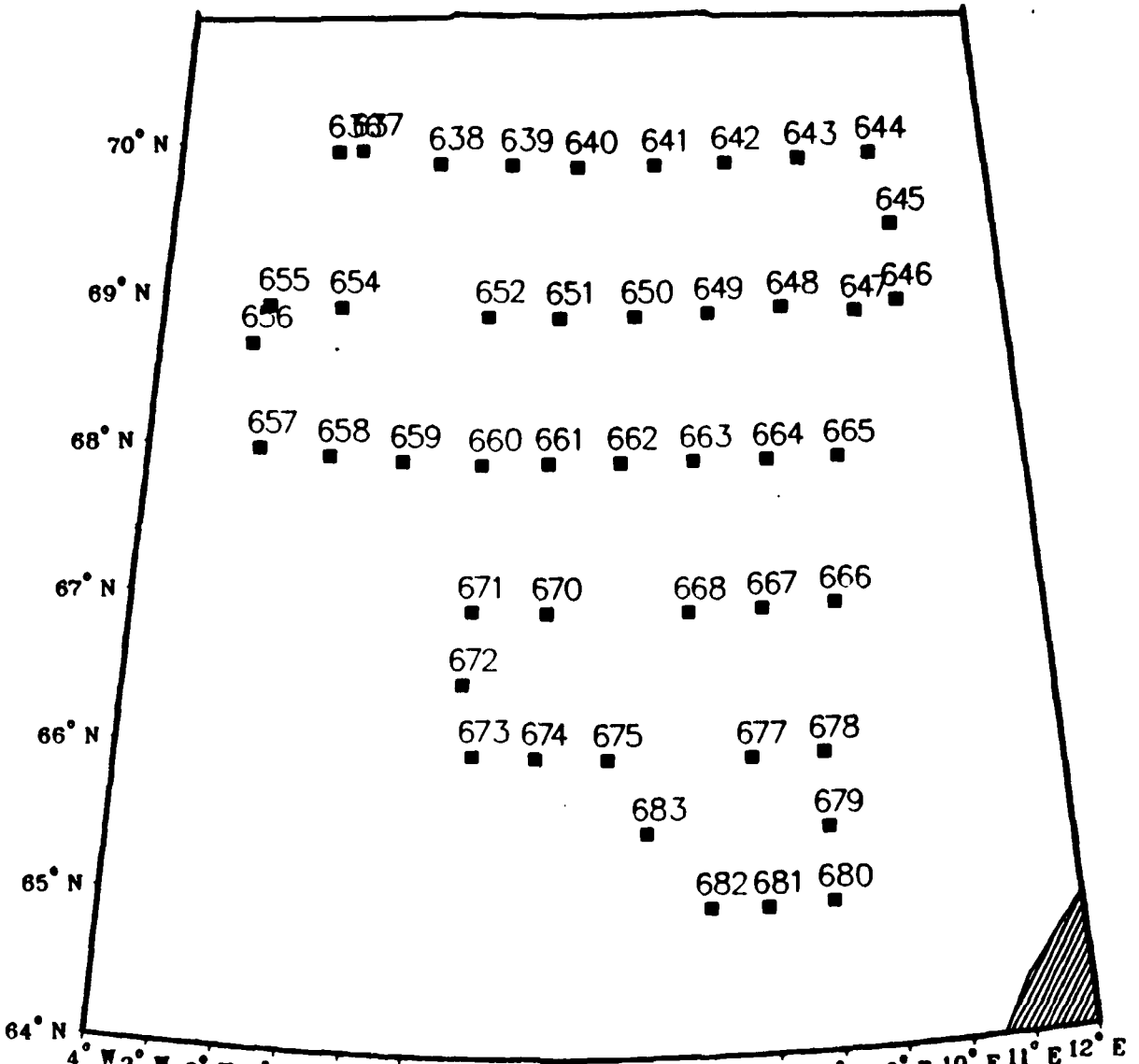

28 May 1987
100 meters
68° N
67° N
66° N
65° N
64° N
63° N
62° N
61° N
6° W 5° W 4° W 3° W 2° W 1° W 0° 1° E 2° E 3° E 4° E 5° E 6° E 7° E 8° E
3.5
5.3
5.0
3.2
3.9
3.5
4.8
4.3 4.7
6.1
4.6
4.1
6.4
4.9
6.9
4.3
6.7
6.5
3.8
6.0
7.0
6.7
8.1
5.7
6.6
6.3
7.6
5.8
8.1
7.1
7.6
7.5
7.3
7.3
6.9
7.1
7.2
6.9
7.1
8.1
7.1
8.1
6.0
6.2
7.4
6.3
7.6
5.9
7.6
8.7
6.3
7.3
8.6
6.5
8.4
6.2
6.2
8.5
6.5
8.4
8.0
7.9
8.2
7.8
8.8
7.6
8.5
7.5
8.1


28 May 1987
200 meters
68° N
67° N
66° N
65° N
64° N
63° N
62° N
61° N
6° W 5° W 4° W 3° W 2° W 1° W 0° 1° E 2° E 3° E 4° E 5° E 6° E 7° E 8° E
3.1
4.5
4.2
2.8
3.3
3.3
3.7
4.0 4.4
5.7
3.3 4.1
4.8
3.8
6.4
3.6
5.5
6.1
2.9
4.3
6.4
6.2
7.8
4.7
7.2
4.2
6.8
4.3
7.3
6.5
6.5
6.7
7.0
6.5 5.6
6.5
6.7
6.4
6.6
6.8
7.8
6.2
4.8
5.1
6.6
7.6
4.8
8.3
6.6
7.2
4.3
8.3
7.0
6.4
7.9
6.9
4.7
8.2
5.5
7.5
7.4
7.5
7.3
8.6

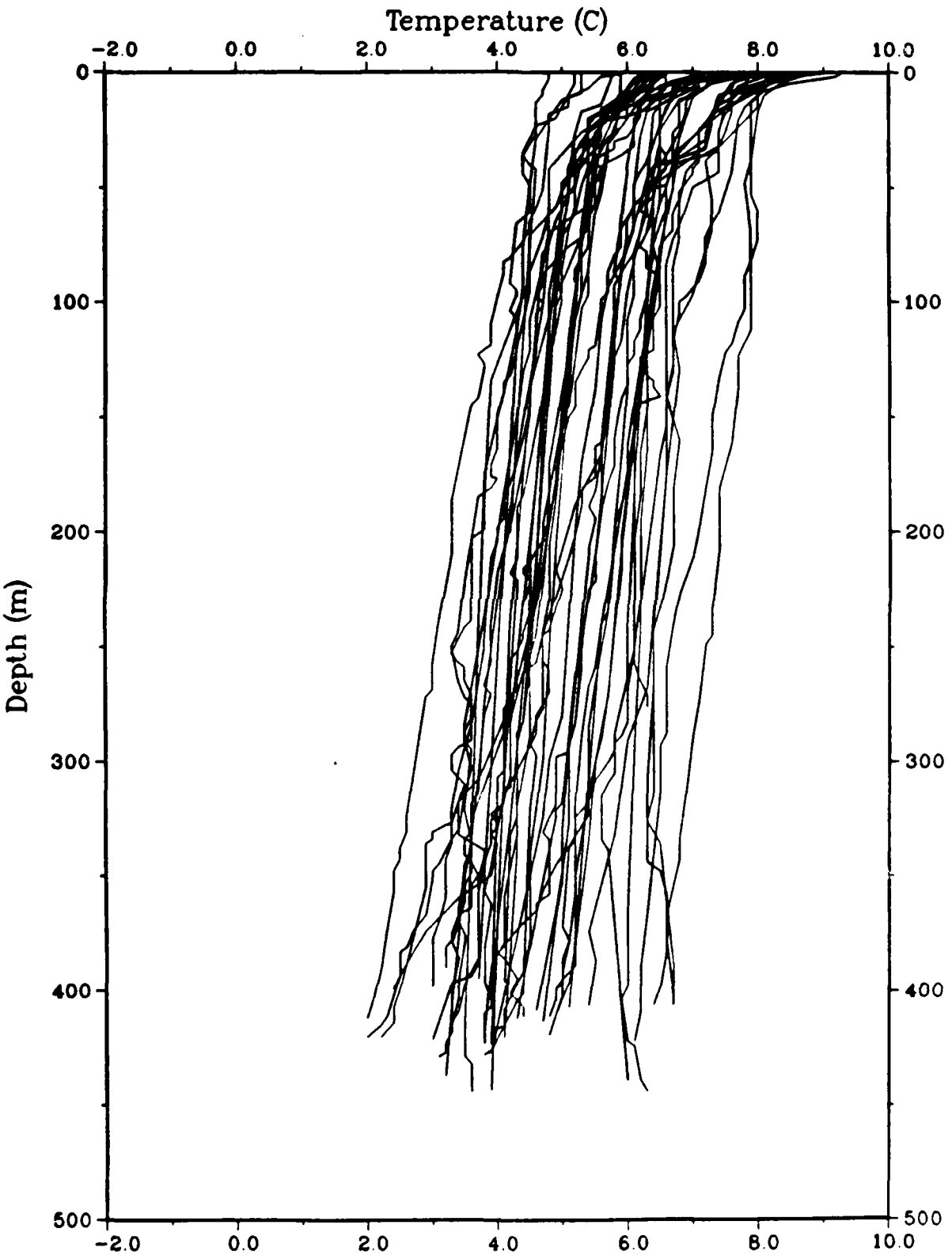

28 May 1987
300 meters
68° N
67° N
66° N
65° N
64° N
63° N
62° N
61° N
6° W 5° W 4° W 3° W 2° W 1° W 0° 1° E 2° E 3° E 4° E 5° E 6° E 7° E 8° E
2.7
3.6
3.0
2.6
2.4
2.5
2.6
3.4 3.9
5.3
2.3 3.3
3.8
2.6
6.1
2.3
4.4
5.0
3.4
2.2
5.9
4.8
6.9
3.6
2.9
6.3
3.1
6.2
6.1
6.1
6.8
6.0
5.6
3.5
6.0
5.8
6.2
5.1
7.1
2.7
3.2
3.5
6.1
7.6
7.0
3.2
7.8
6.2
4.8
7.6
2.8
7.2
8.2
6.0
3.6
6.5
7.1
6.7
8.5

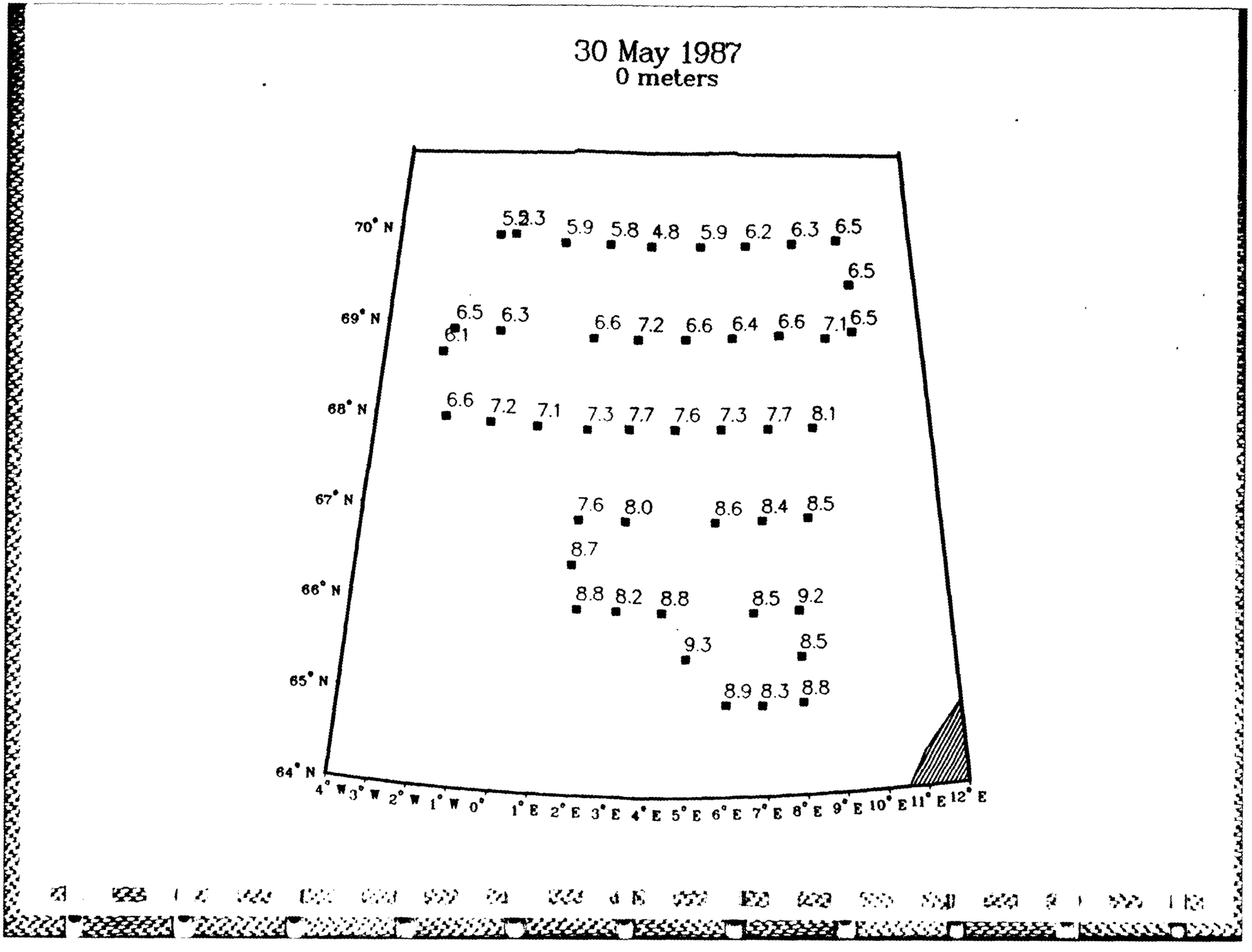

28 May 1987
400 meters
68° N
67° N
66° N
65° N
64° N
63° N
62° N
61° N
6° W 5° W 4° W 3° W 2° W 1° W 0° 1° E 2° E 3° E 4° E 5° E 6° E 7° E 8° E
2.3
2.7
1.7
2.0
1.5
2.0
1.6
2.2 3.7
4.8
1.5 2.4
2.2
5.0
1.3
2.8
3.6
1.4
1.4
5.2
2.1
1.3
5.8
1.4
5.3
5.3
5.3
4.8
6.9
4.2
2.0
4.2
4.7
4.3
3.1
1.5
2.2
2.2
4.7
8.0
6.8
1.5
4.6
3.7
7.3
1.4
6.5
5.7
1.7
6.3
6.2
8.3

30 May 1987
AXBT Stations

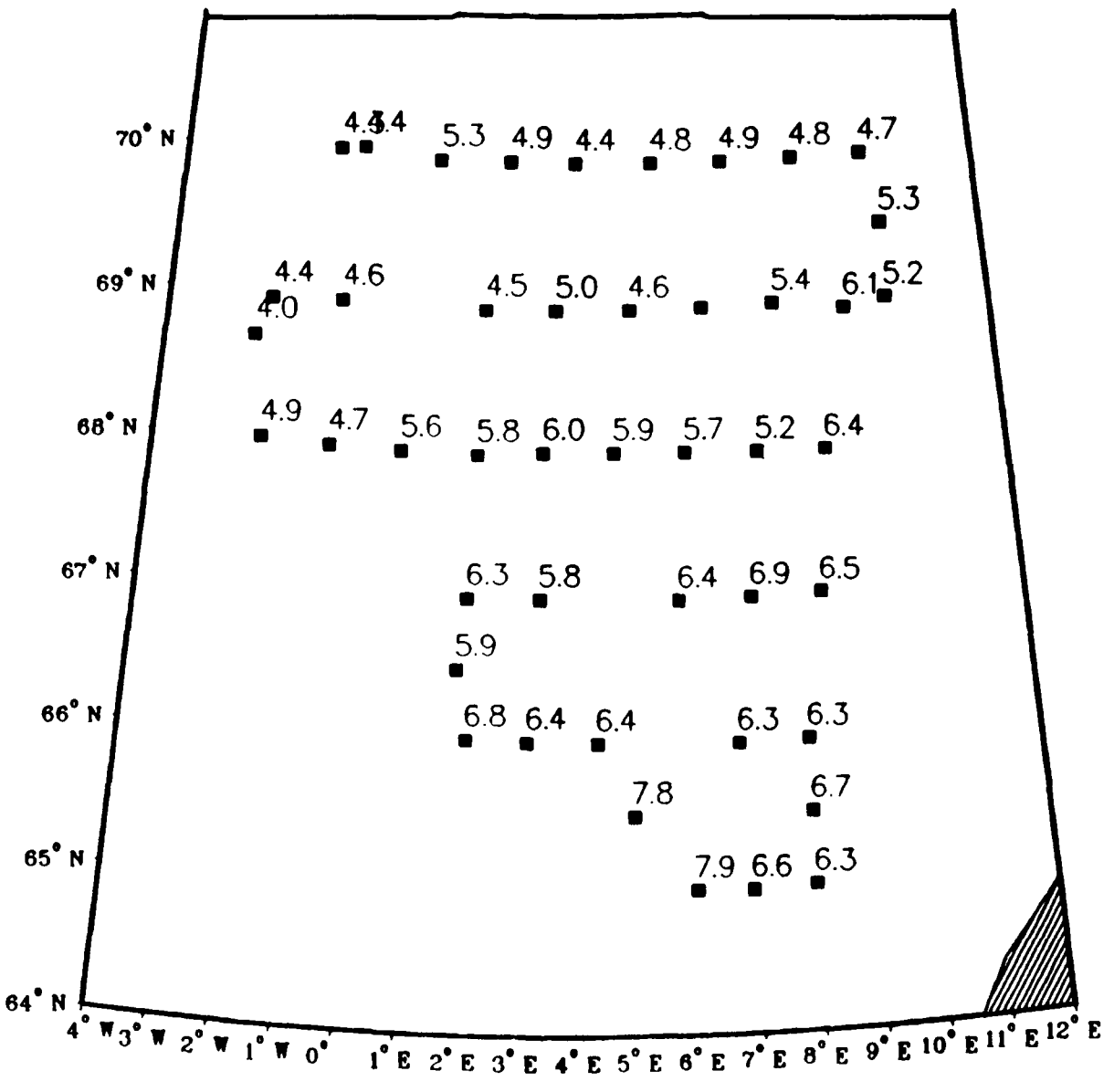


30 May 1987

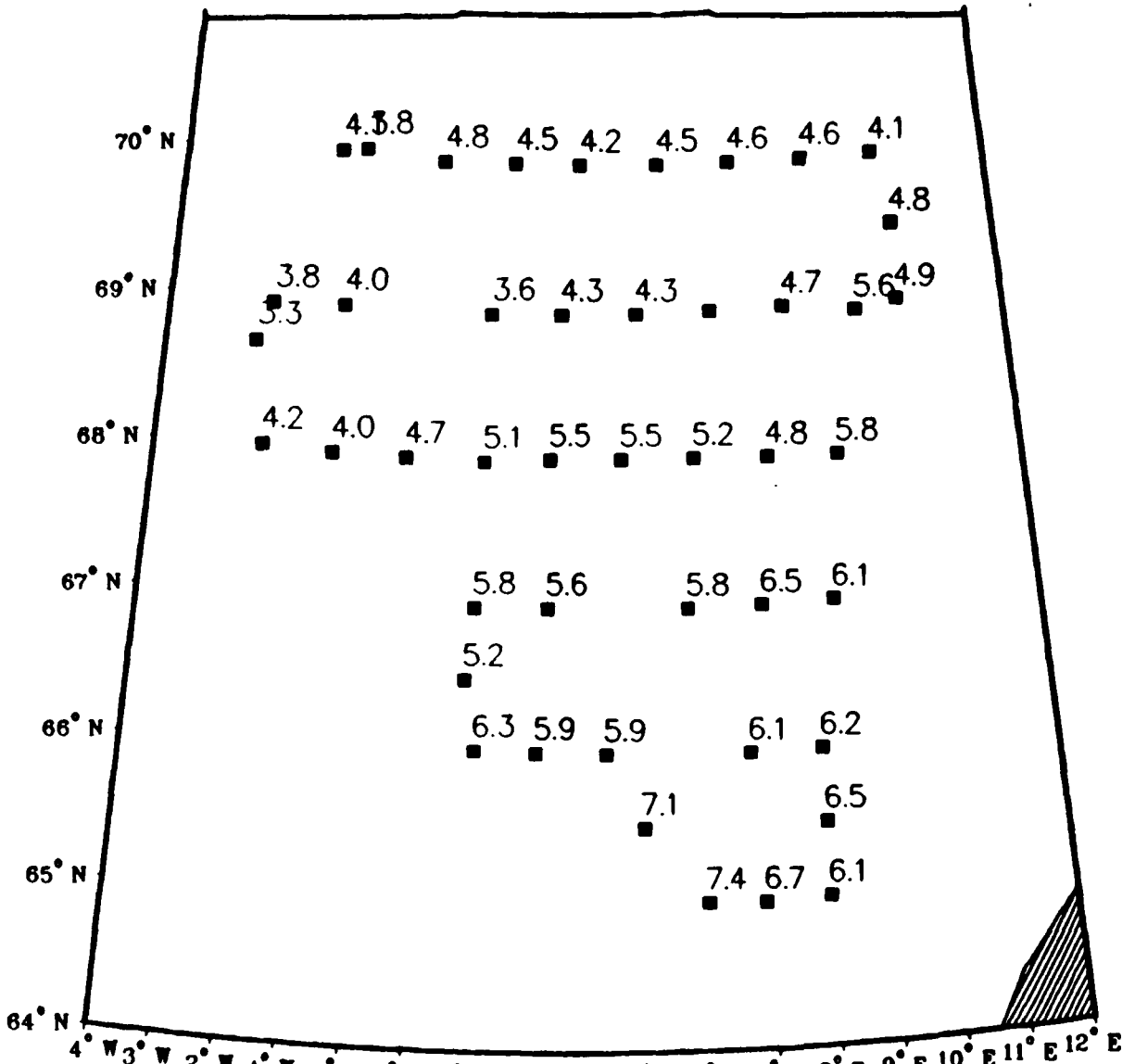



30 May 1987
0 meters
70° N
69° N
68° N
67° N
66° N
65° N
64° N
4° W 3° W 2° W 1° W 0° 1° E 2° E 3° E 4° E 5° E 6° E 7° E 8° E 9° E 10° E 11° E 12° E
5.2 5.3 5.9 5.8 4.8 5.9 6.2 6.3 6.5
6.5
6.5 6.3 6.1 6.6 7.2 6.6 6.4 6.6 7.1 6.5
6.6 7.2 7.1 7.3 7.7 7.6 7.3 7.7 8.1
7.6 8.0 8.6 8.4 8.5
8.7
8.8 8.2 8.8 8.5 9.2
9.3 8.5
8.9 8.3 8.8

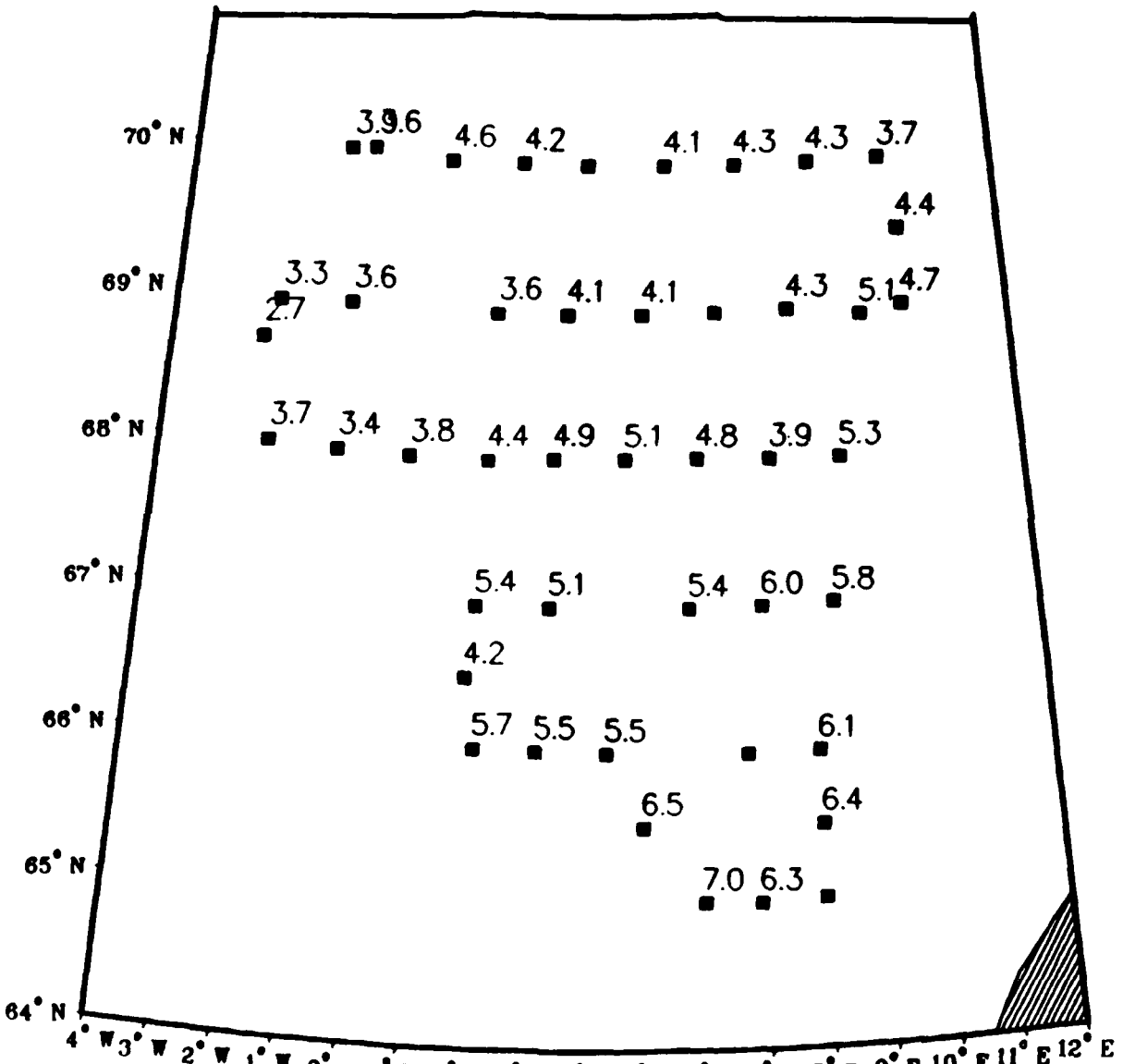
30 May 1987
100 meters



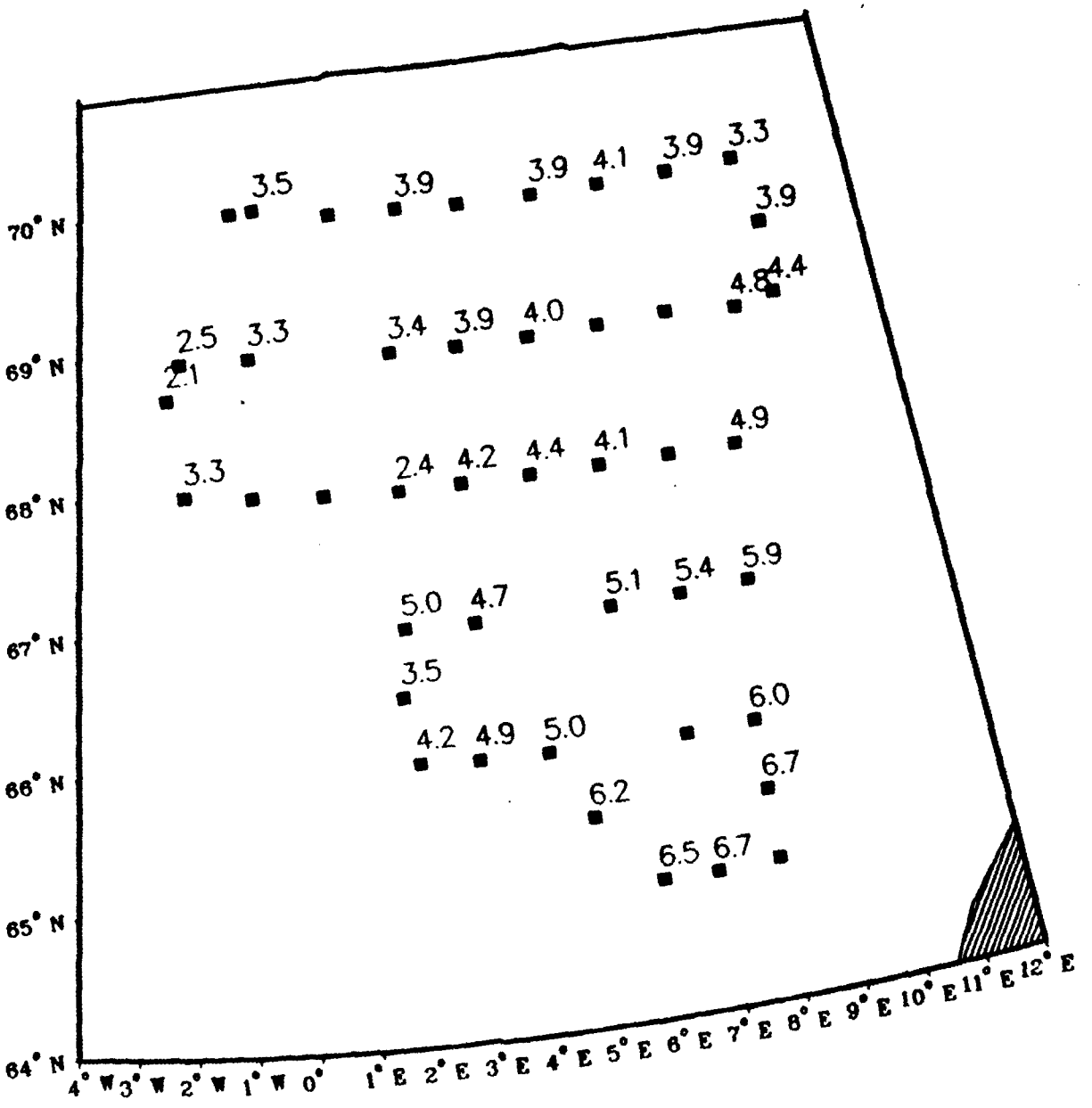
30 May 1987
200 meters



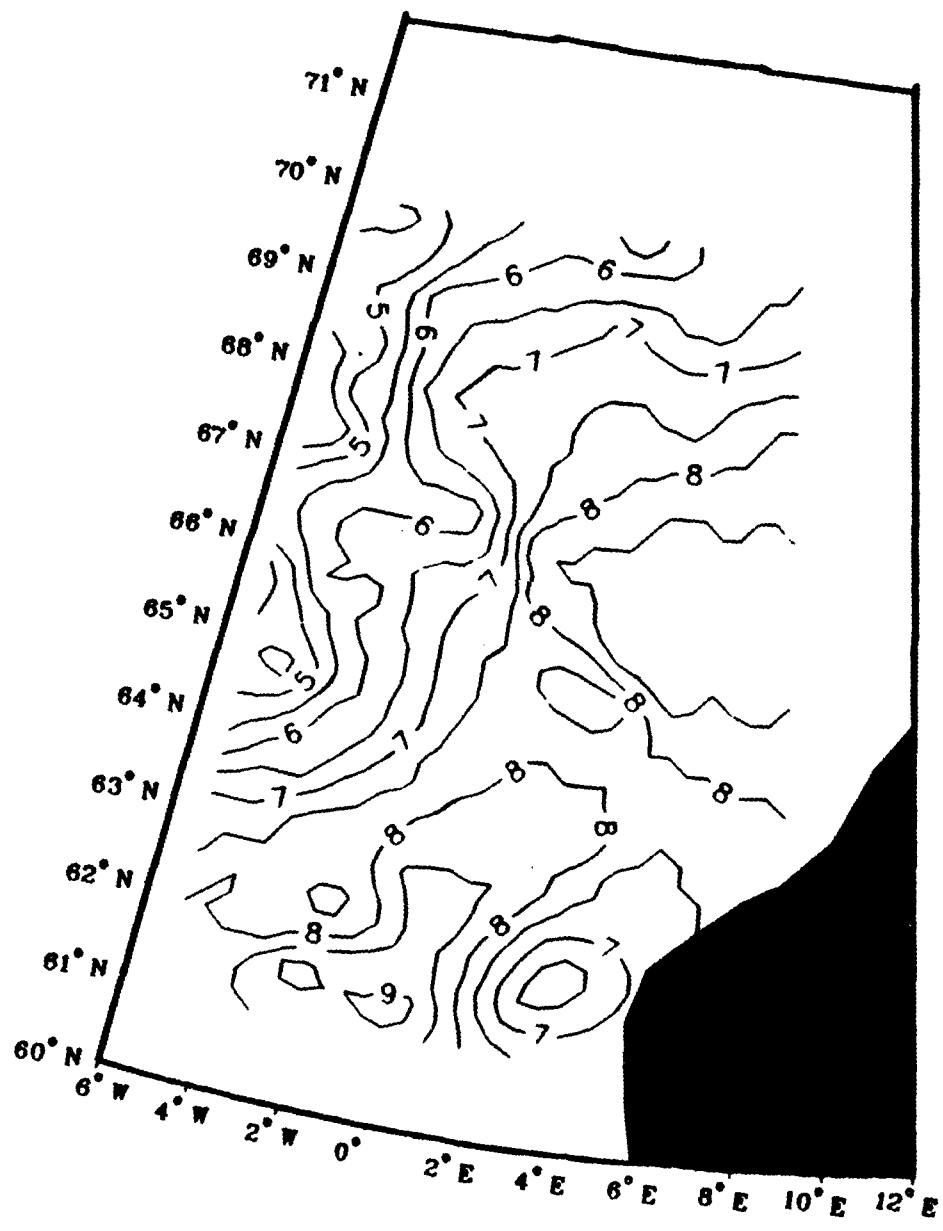
30 May 1987
300 meters



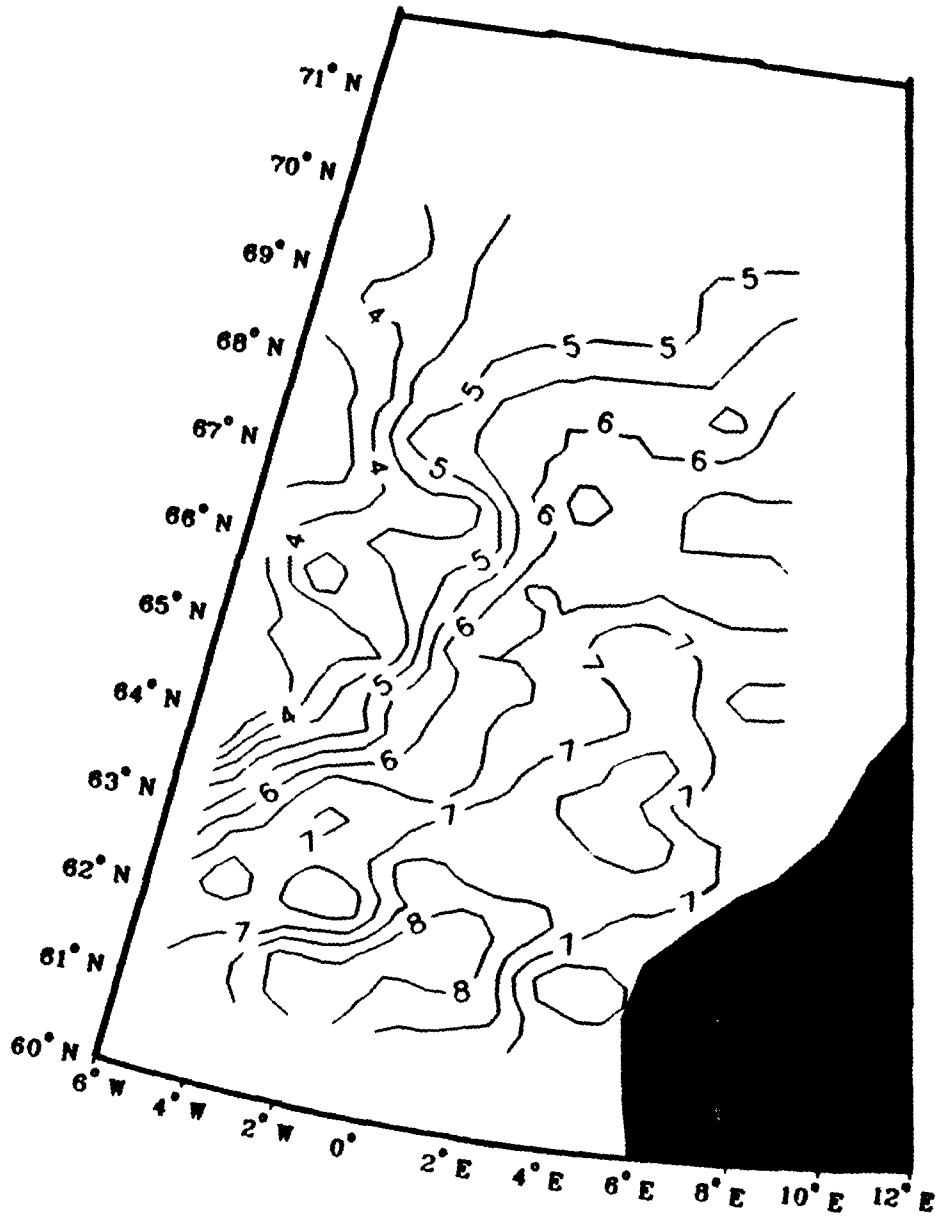
30 May 1987
400 meters



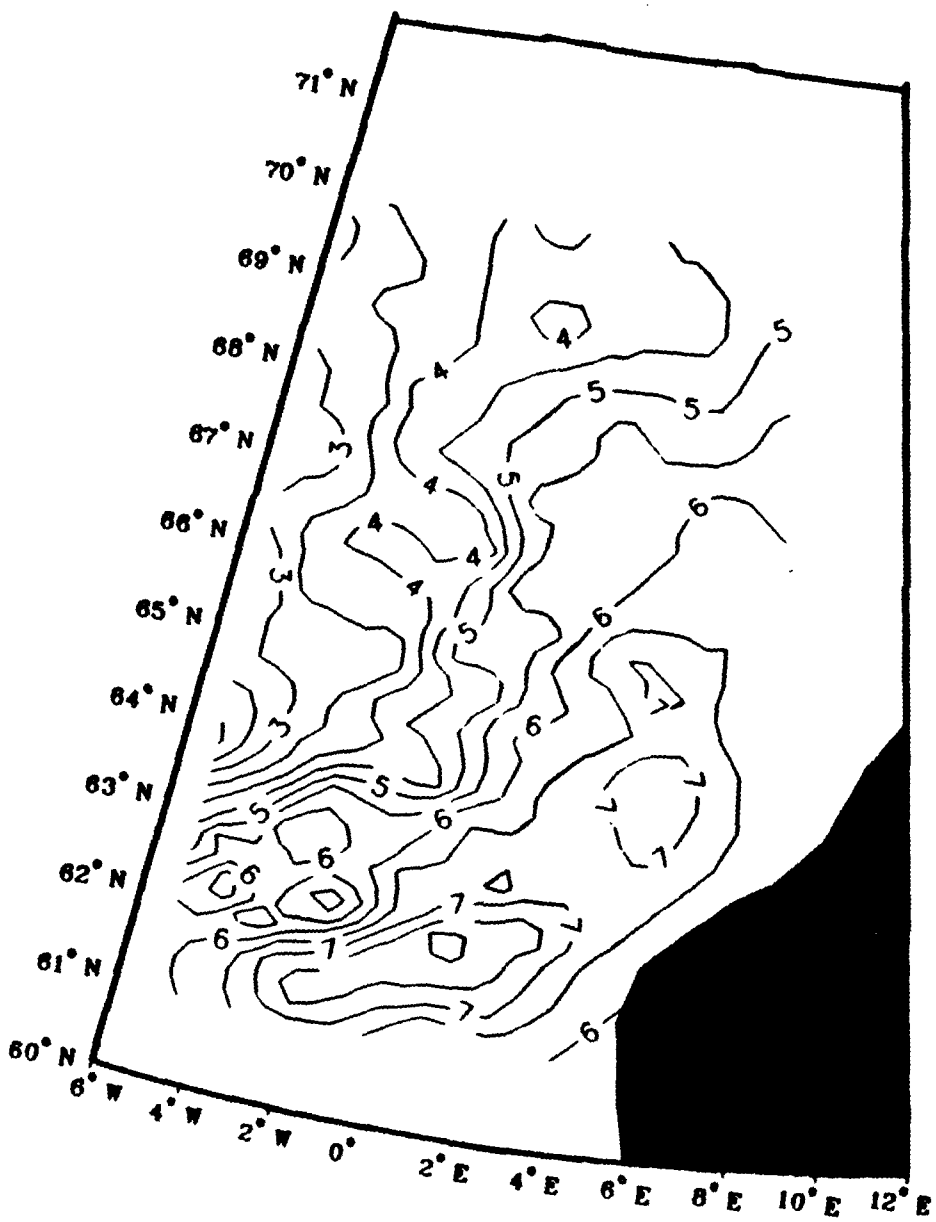
Temperature
28–30 May 1987
0 meters



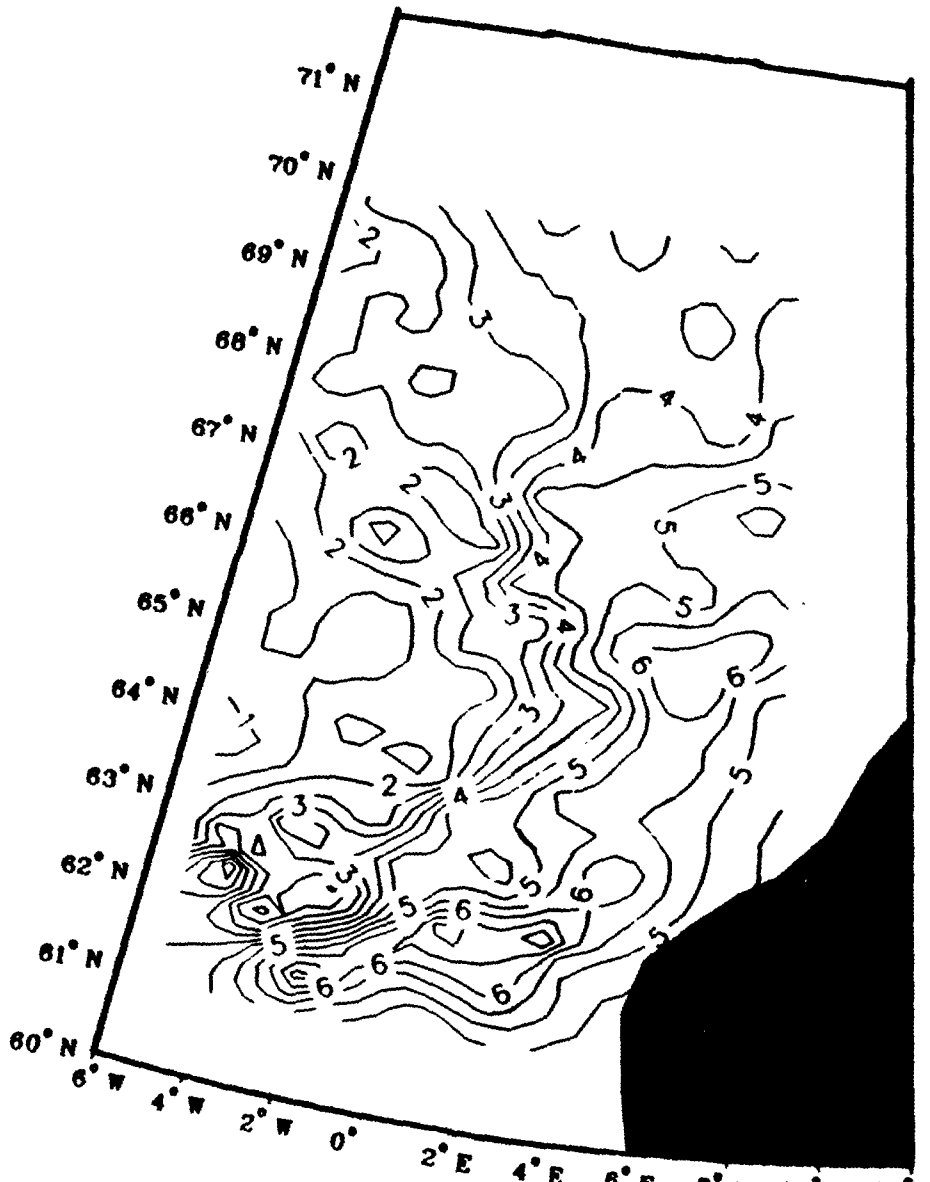
Temperature
28–30 May 1987
100 meters



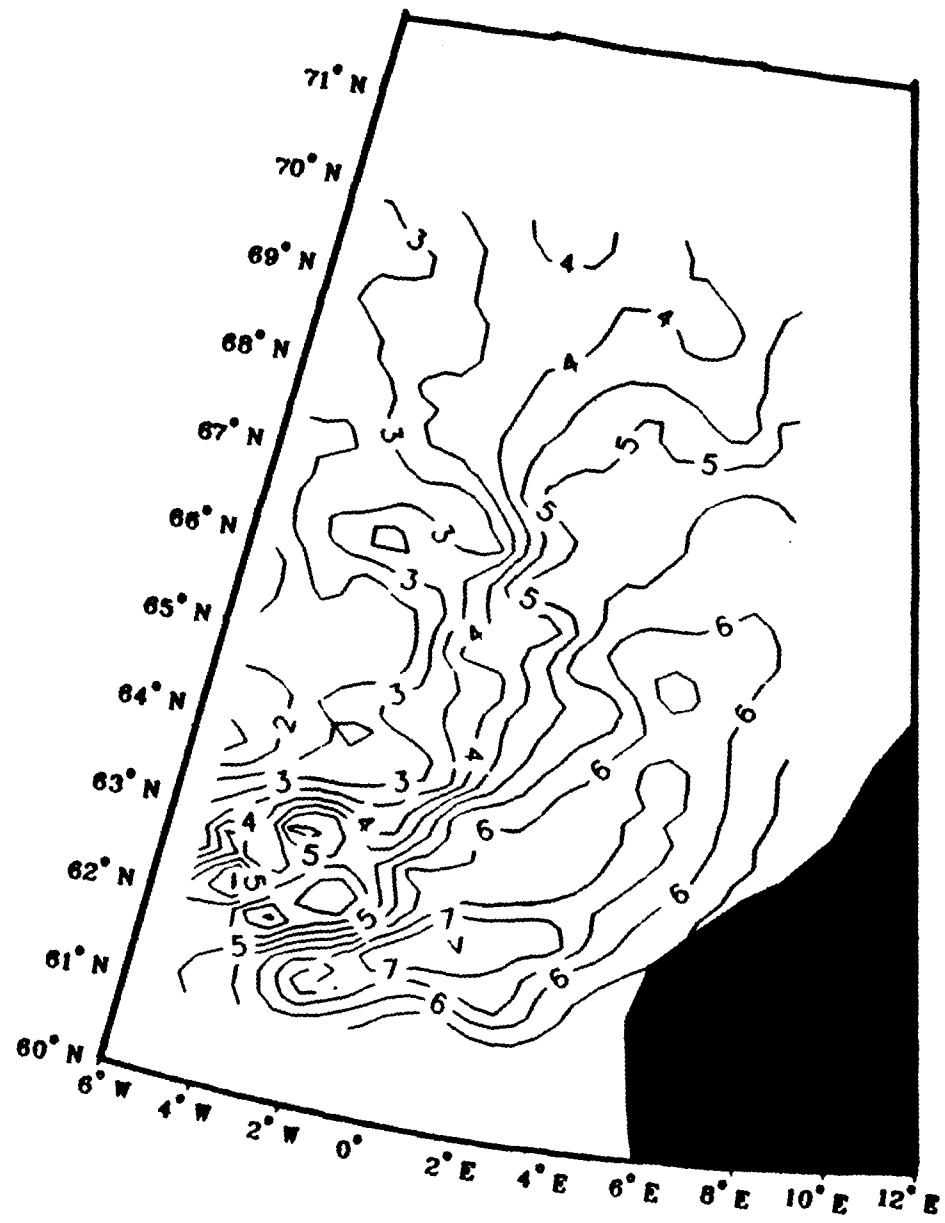
Temperature
28–30 May 1987
200 meters

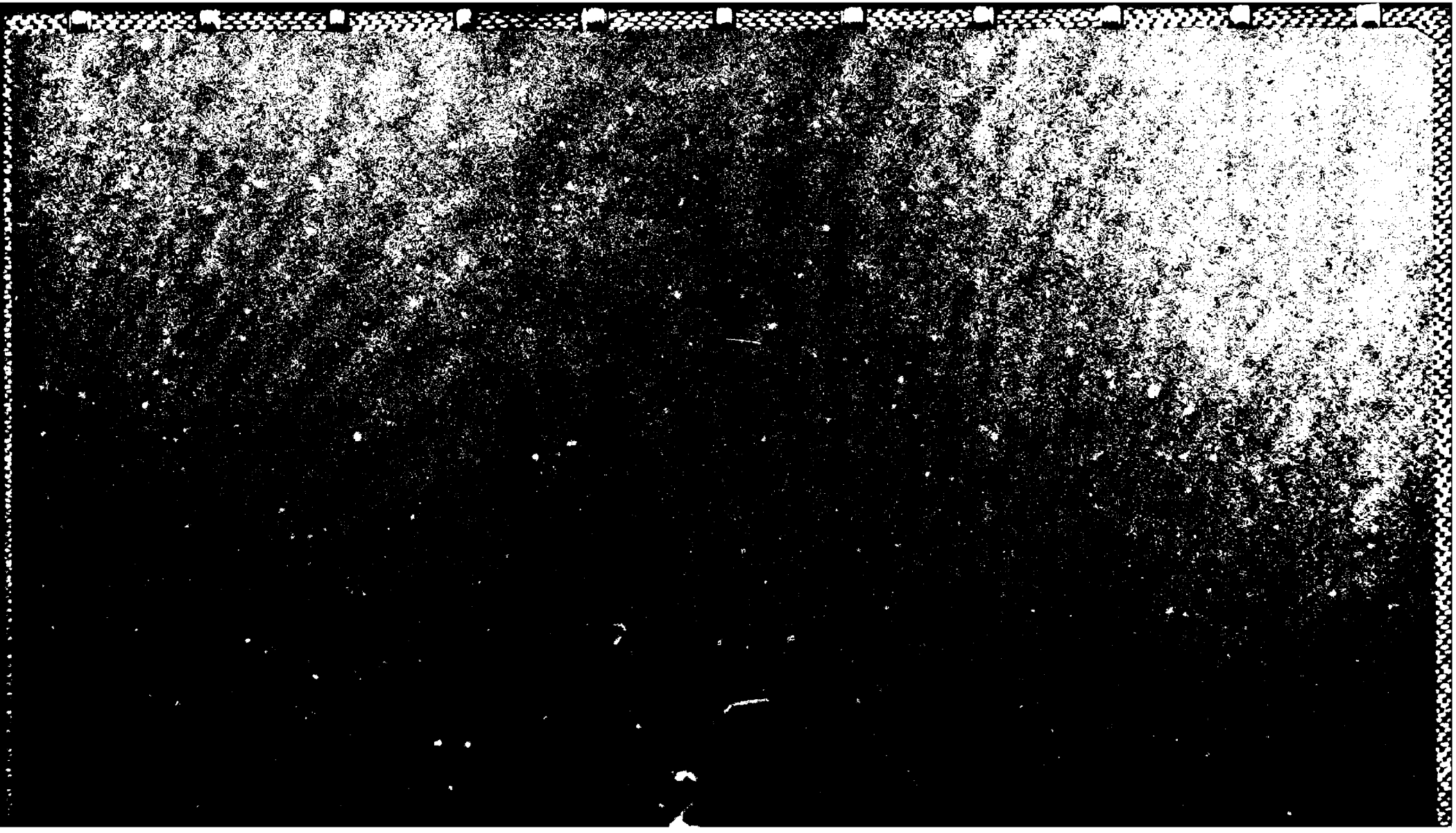


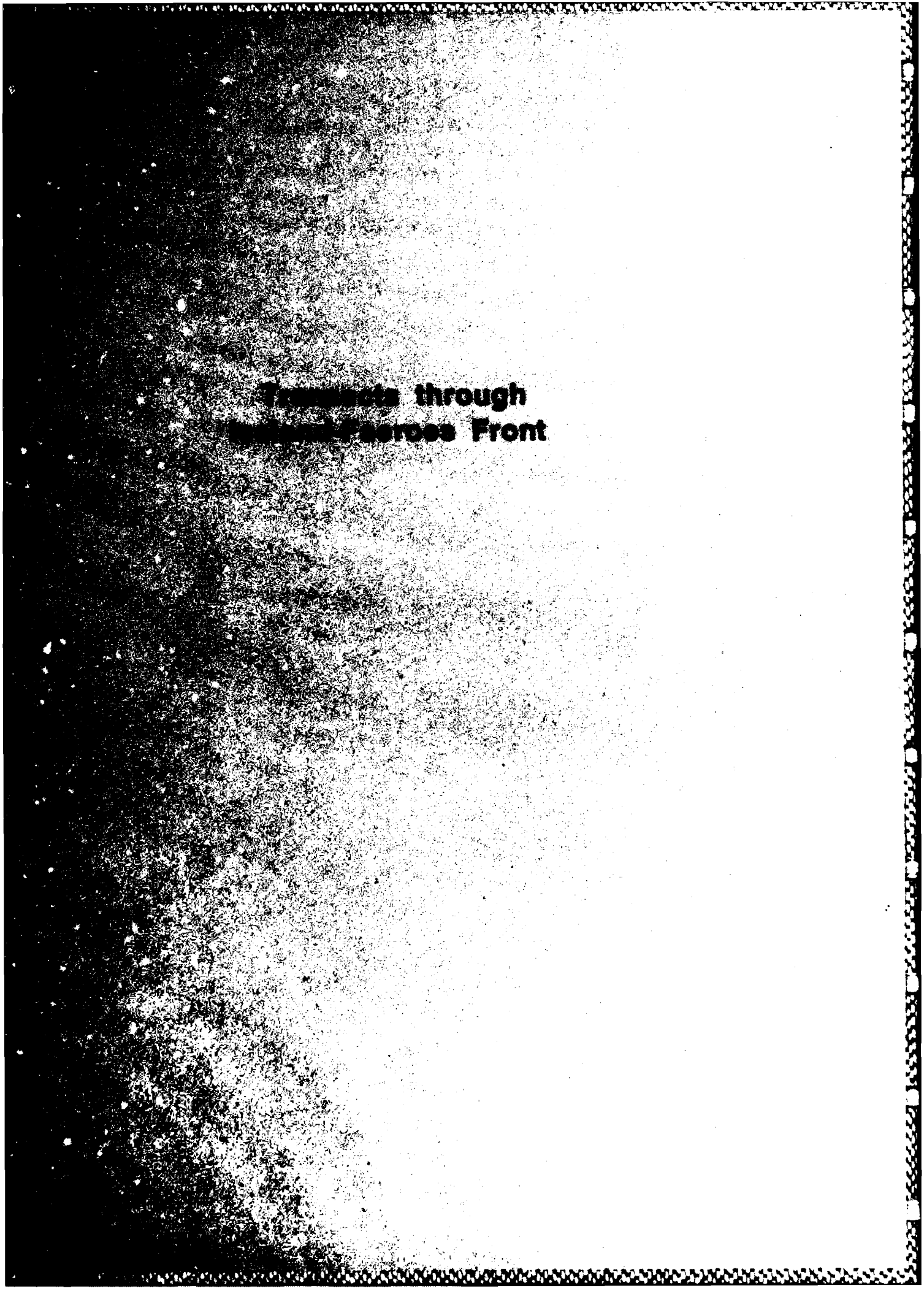
Temperature
28–30 May 1987
400 meters

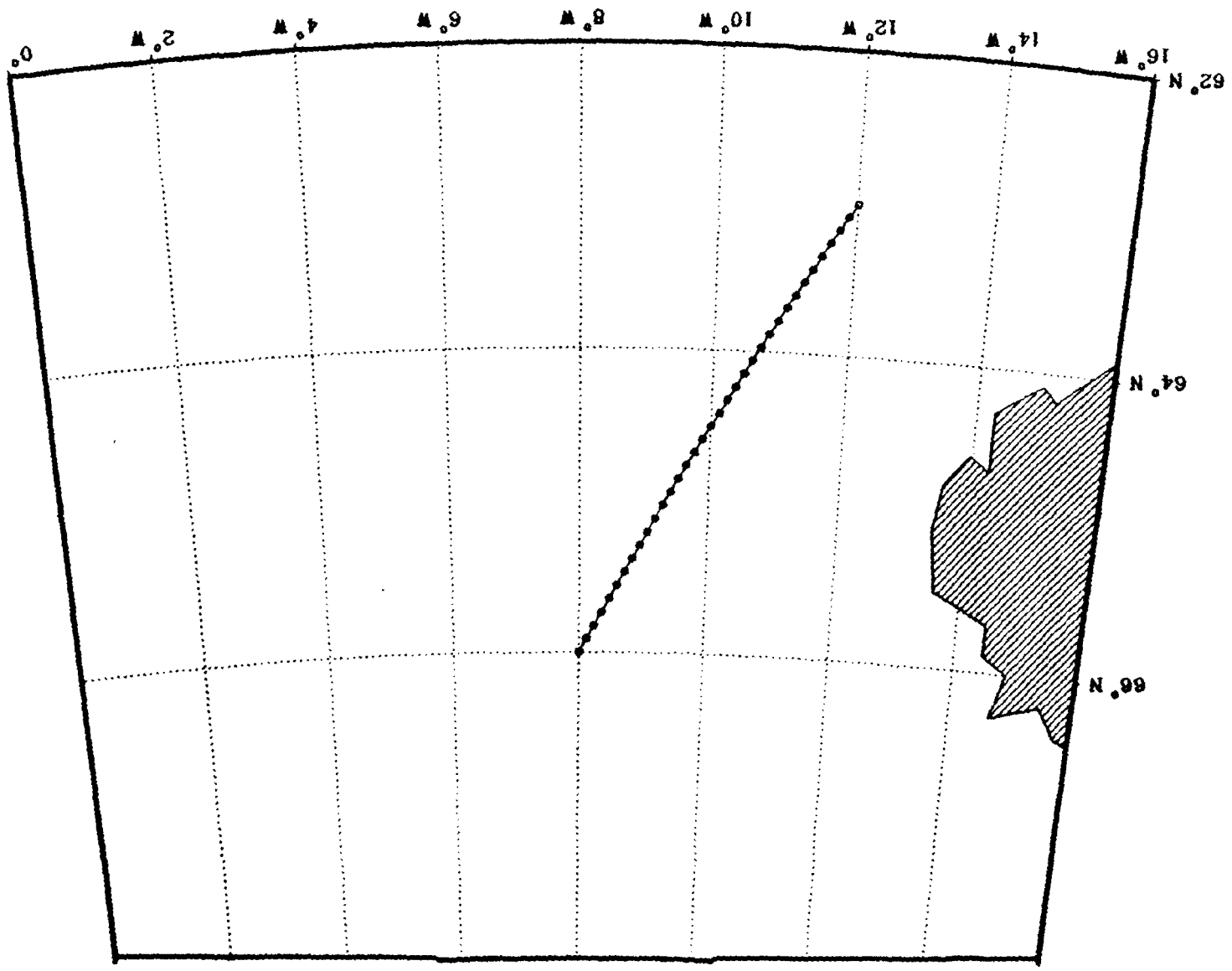


Temperature
28–30 May 1987
300 meters



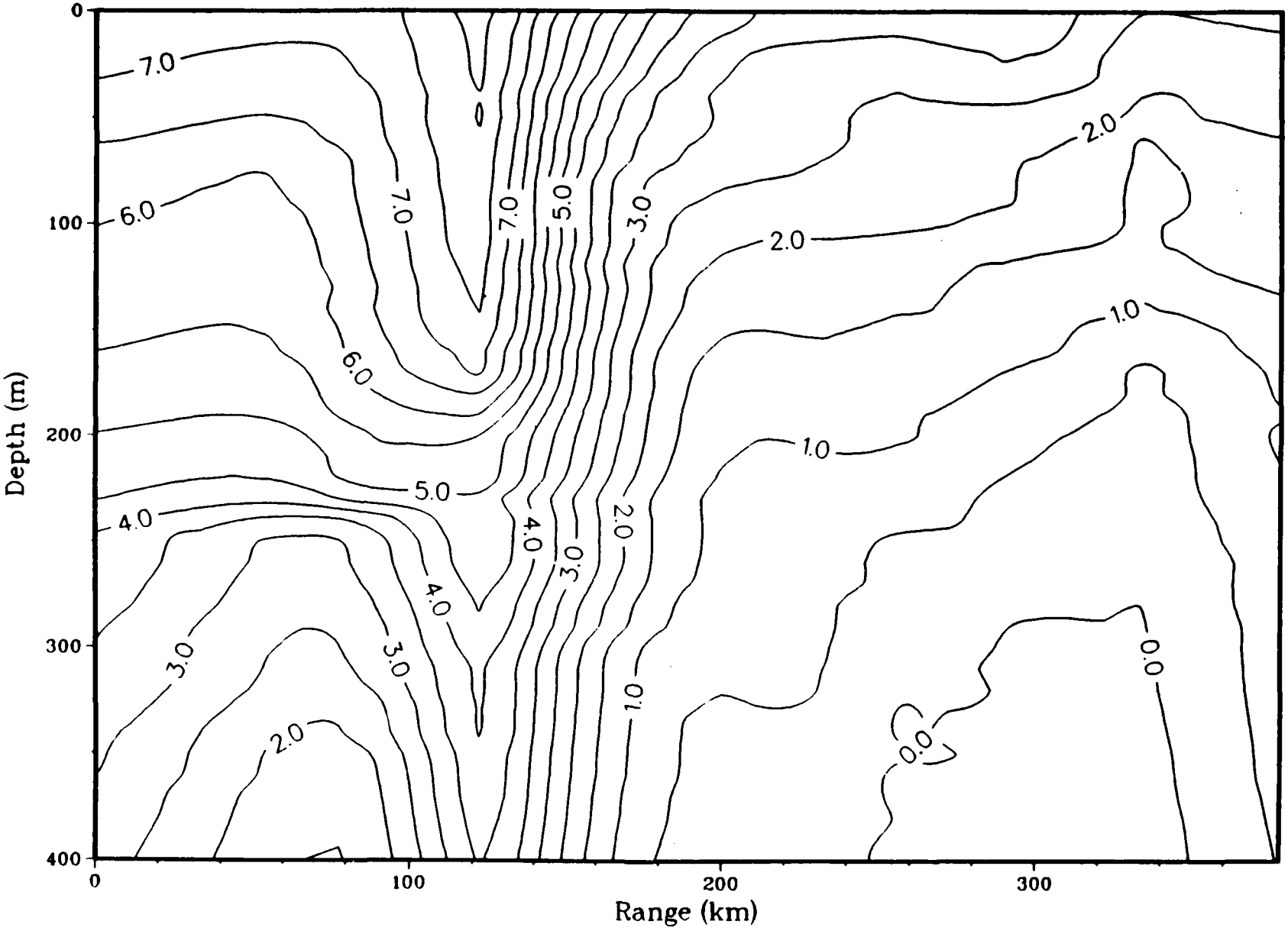


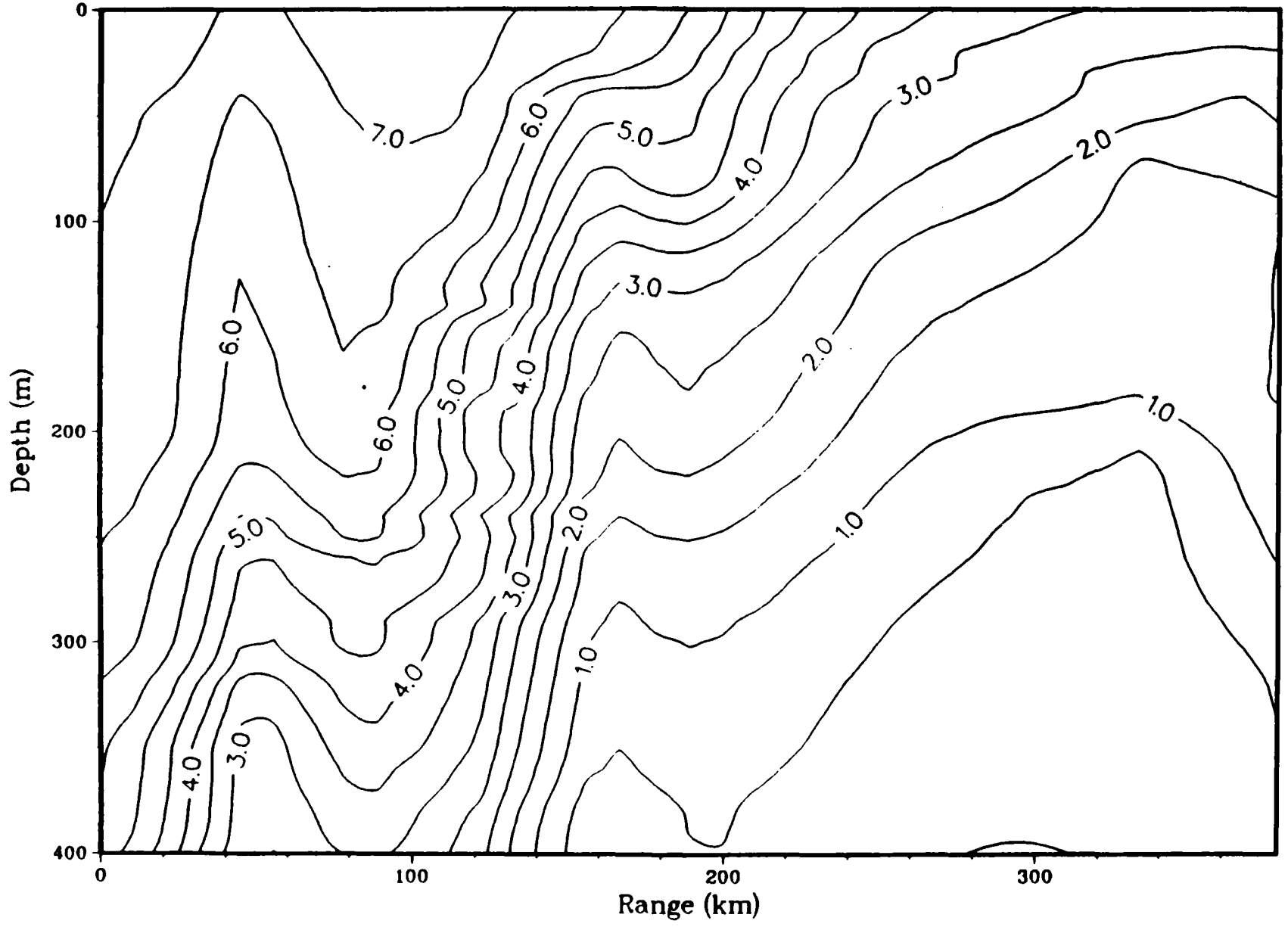

through
Front



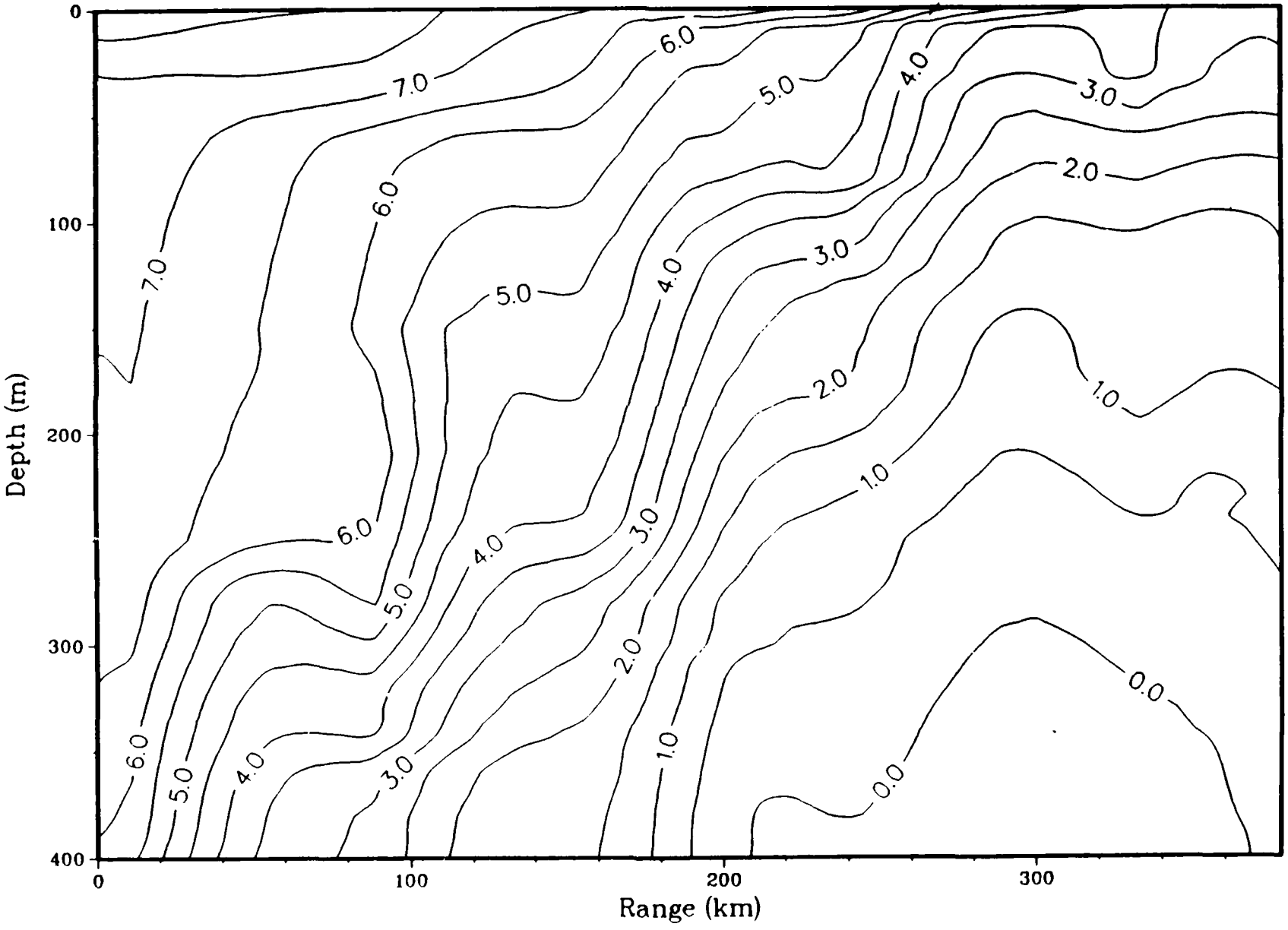
15–26 May 1987
(-12.0, 63.0) to (-8.0, 66.0)

Temperature
15 May 1987
(-12.0, 63.0) to (-8.0, 66.0)




Temperature
18 May 1987
(-12.0, 63.0) to (-8.0, 66.0)
Depth (m)
0
100
200
300
400
0
100
200
300
Range (km)
7.0
6.0
5.0
4.0
3.0
2.0
1.0

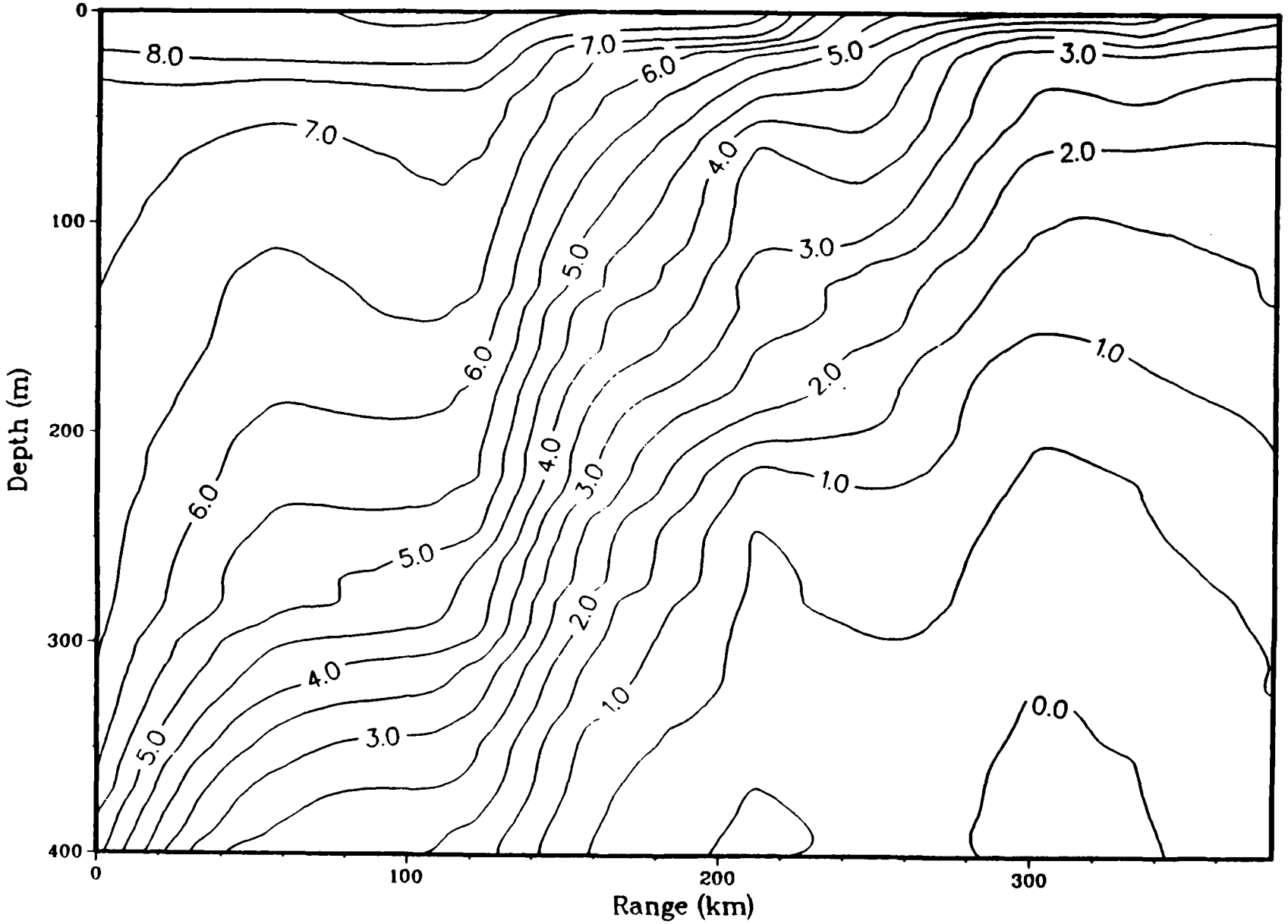
Temperature
22 May 1987
(−12.0, 63.0) to (−8.0, 66.0)



Temperature

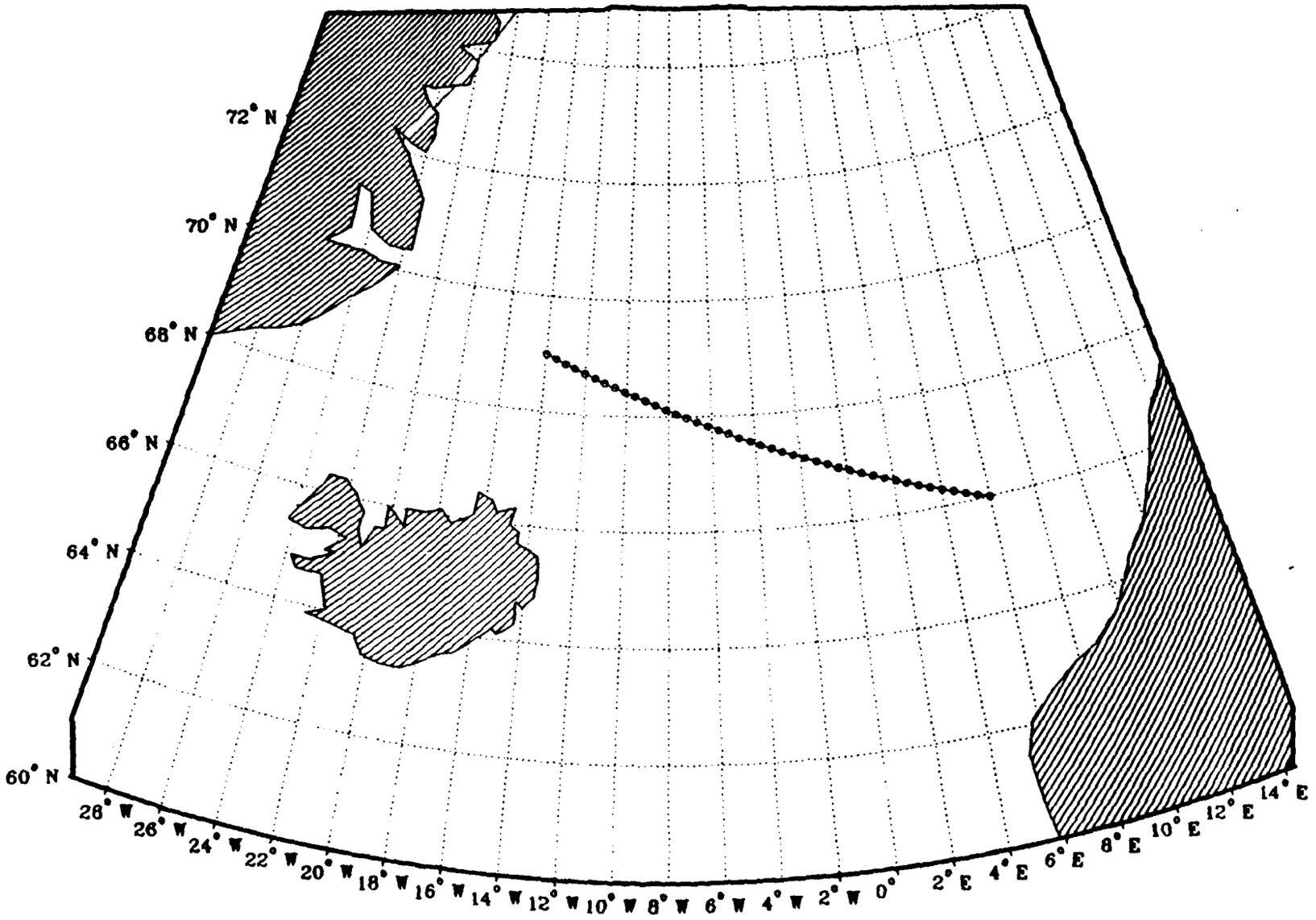
26 May 1987

(−12.0, 63.0) to (−8.0, 66.0)



Transect through Jan Mayen and Norwegian Current Fronts

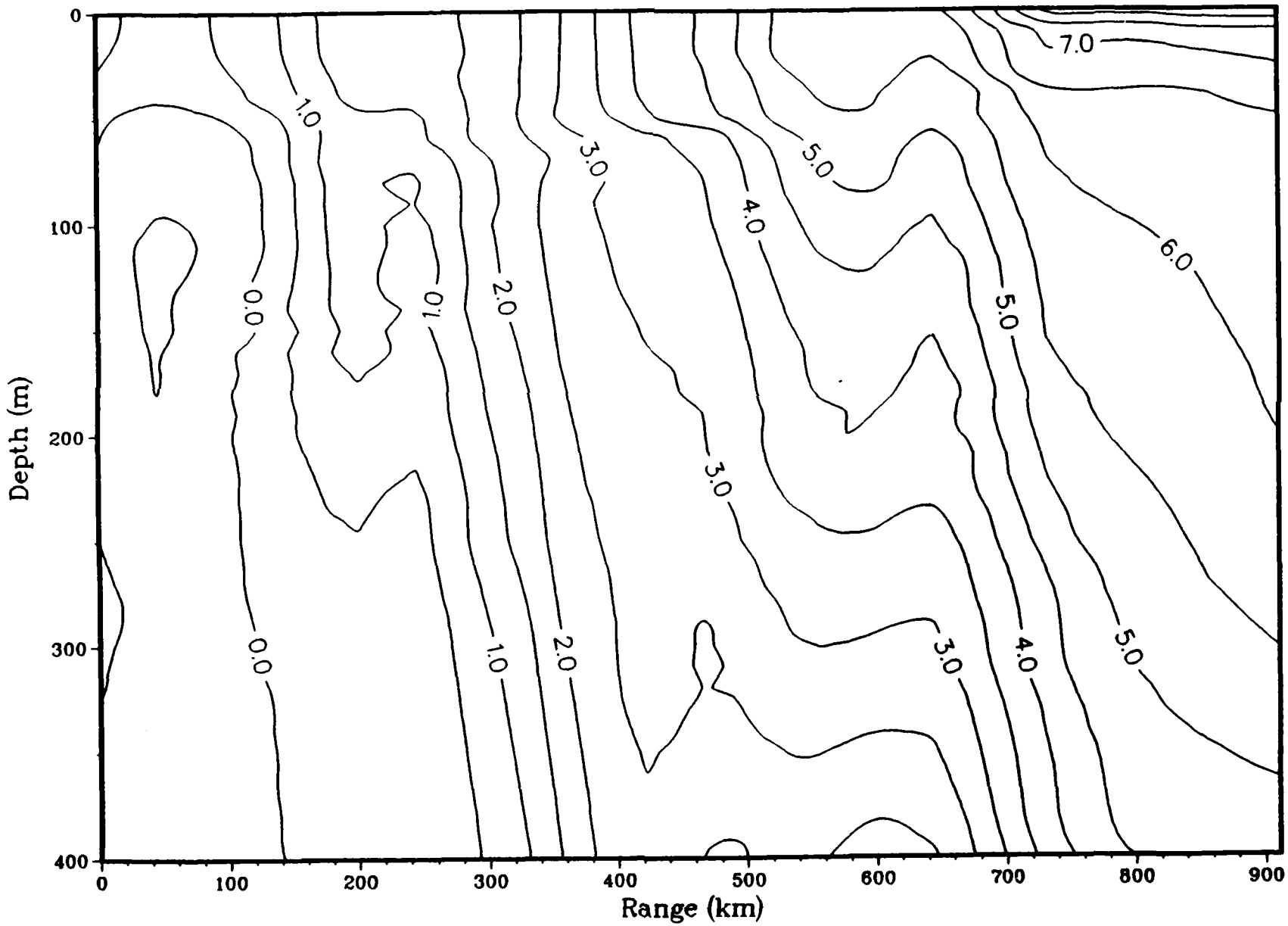
20–30 May 1987
(–14.0, 69.0) to (6.0, 66.0)

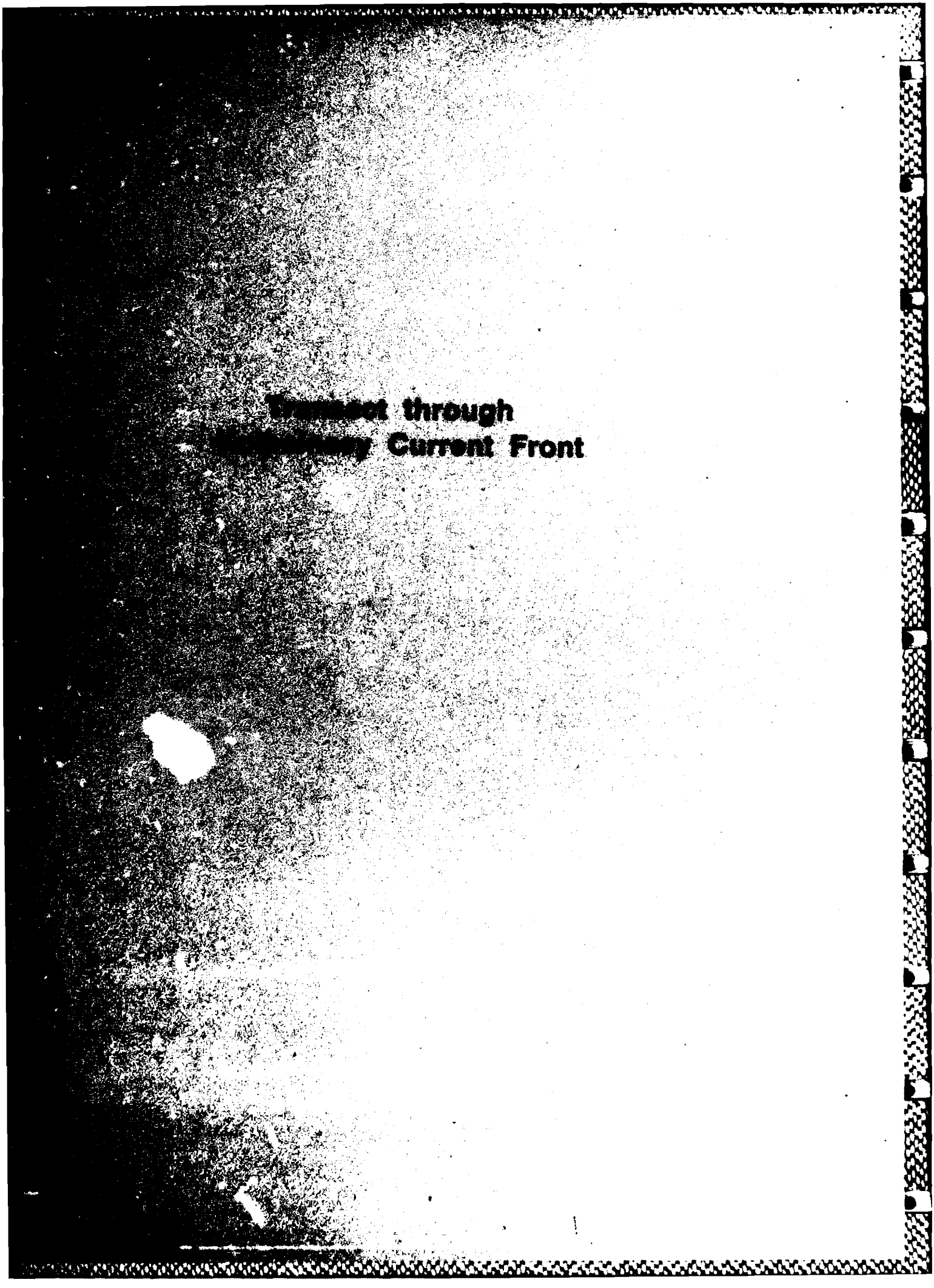


Temperature

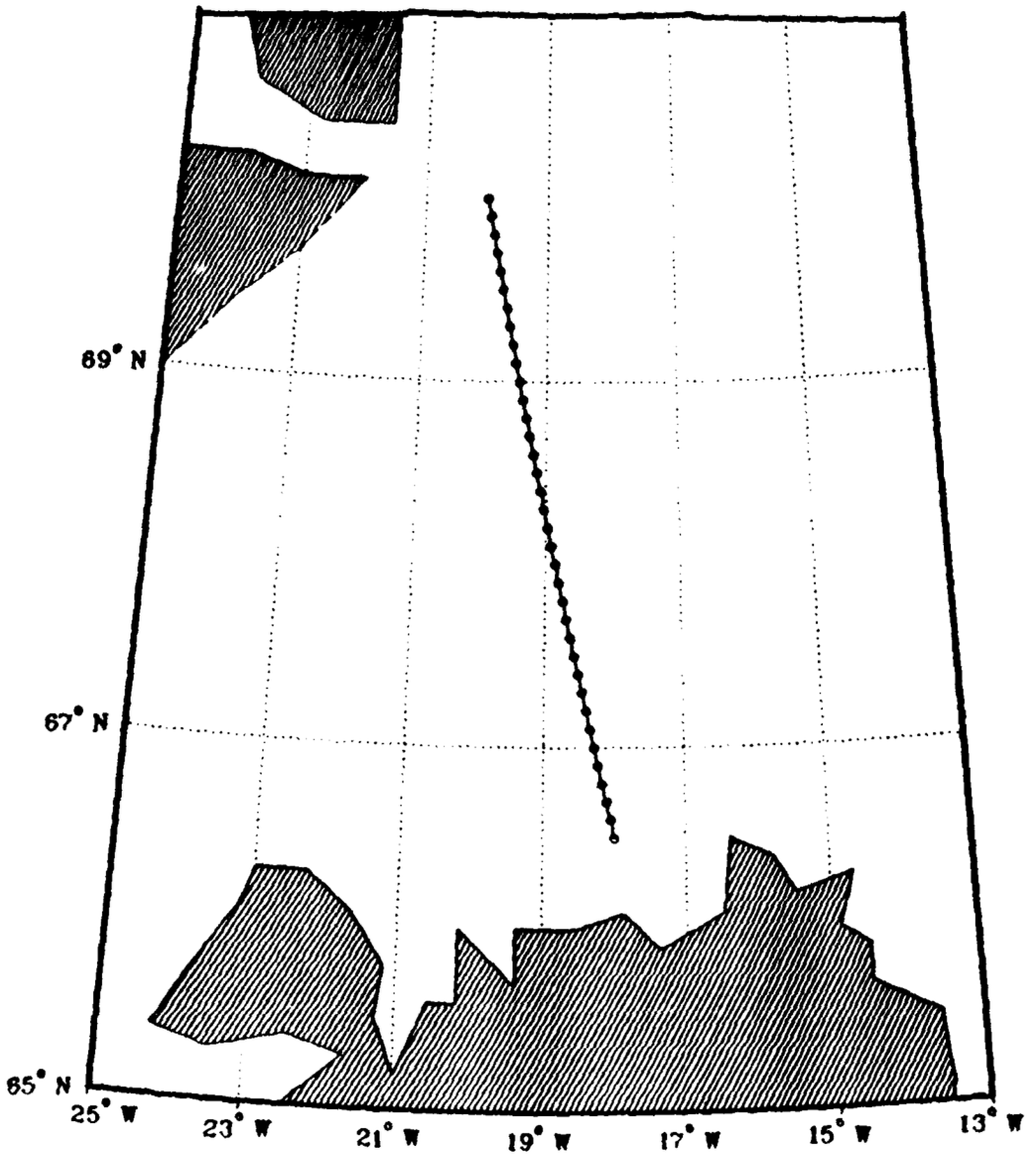
20–30 May 1987

(–14.0, 69.0) to (6.0, 66.0)

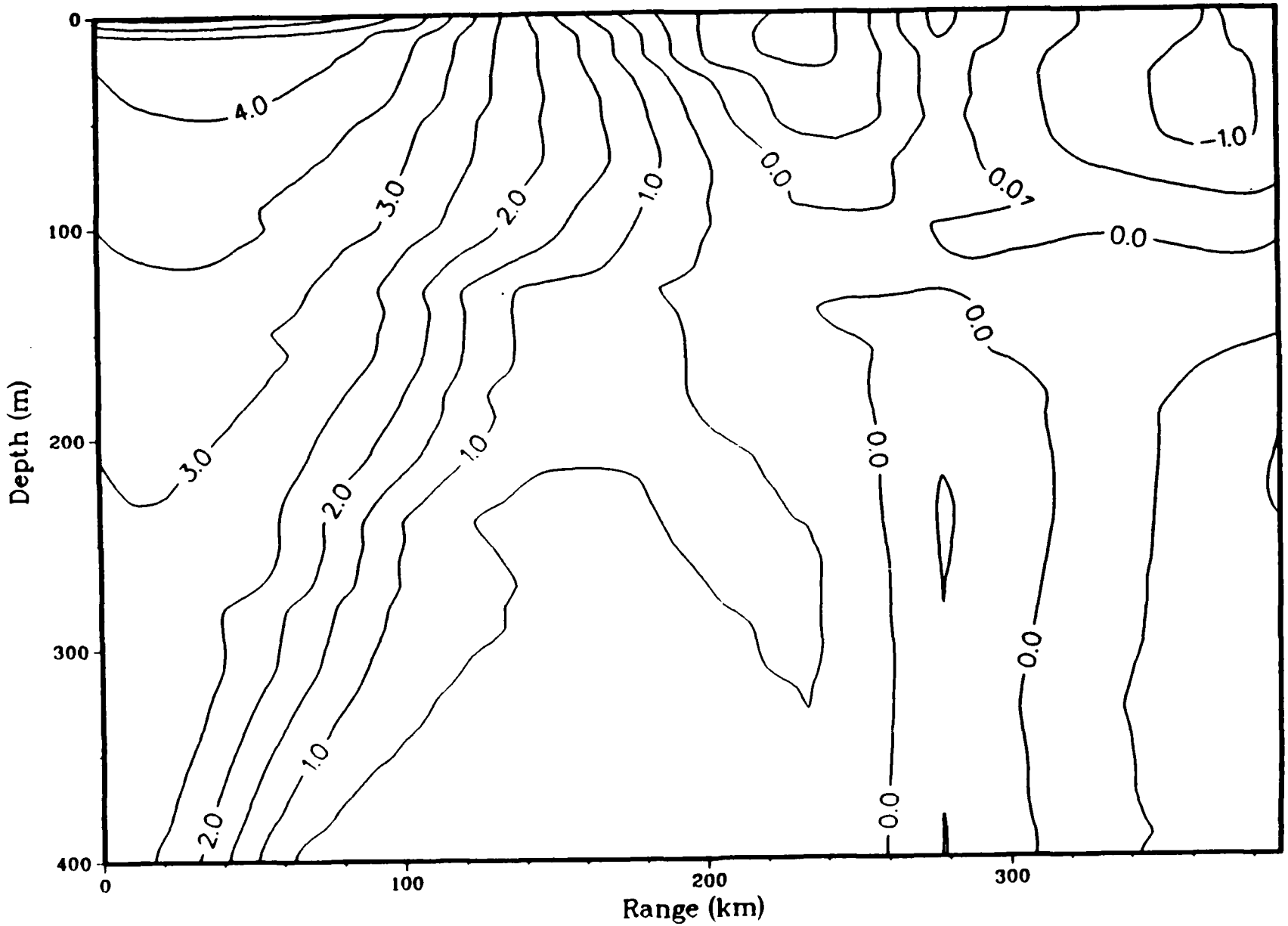



through
Current Front

24 May 1987
(−18.0, 66.5) to (−20.0, 70.0)



Temperature
24 May 1987
(−18.0, 66.5) to (−20.0, 70.0)



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(U) In support of the Tactical Oceanography Prediction Experiment an extensive series of thermal structure measurements have been made in the Iceland and Greenland Seas with emphasis on the Iceland-Faeroe frontal region. A preliminary analysis of these measurements is given.

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